the Petroleum Engineer

FOR MANAGEMENT

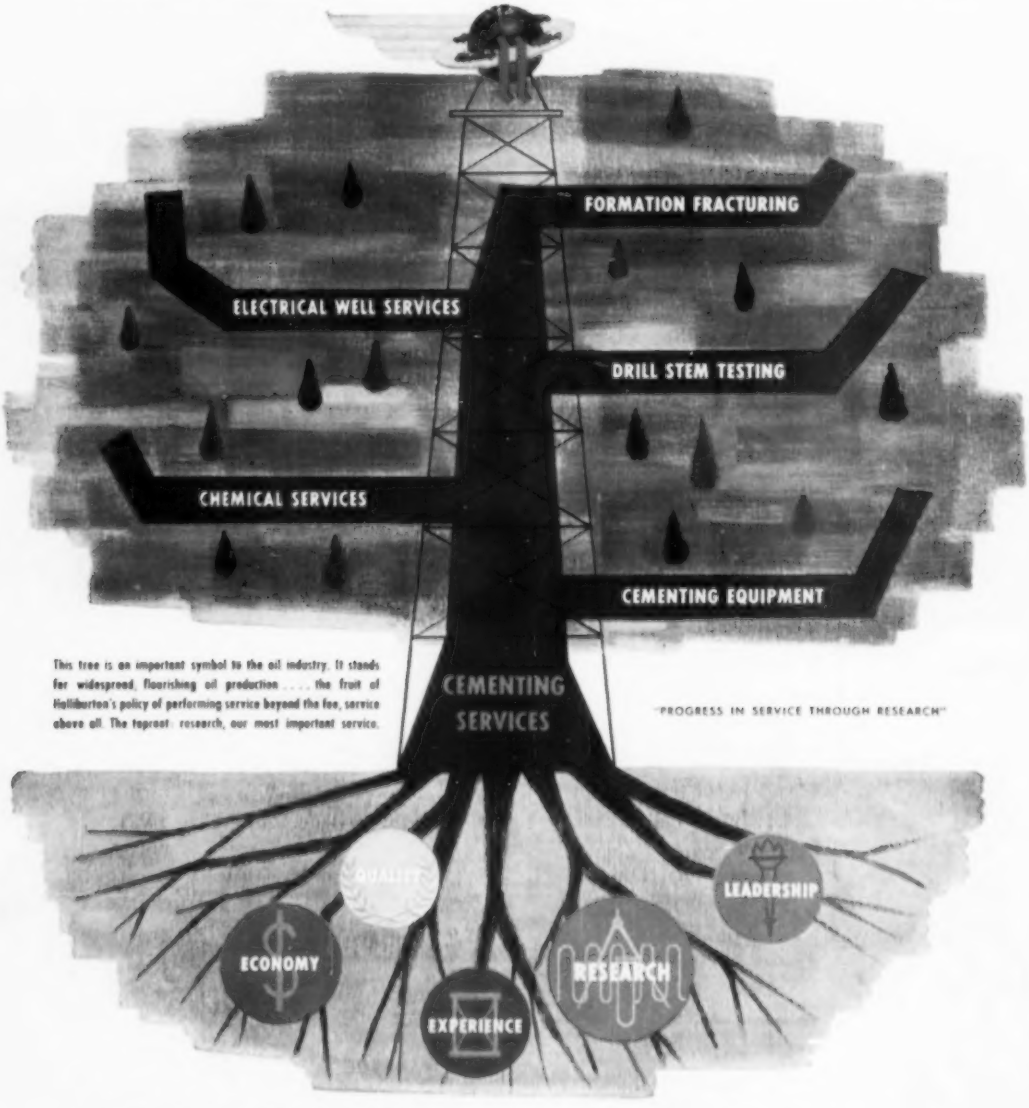
INTEGRATED EDITION OF THE PETROLEUM ENGINEER

Engineer vs Management
A Report From Each

How Refiners Make Hi-Octane Gasoline

Going Into Foreign Operations?

THE HALLIBURTON TREE OF SERVICE



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"PROGRESS IN SERVICE THROUGH RESEARCH"

HALLIBURTON OIL WELL CEMENTING COMPANY
DUNCAN, OKLAHOMA

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the Petroleum Engineer

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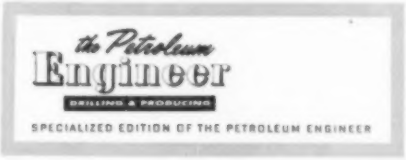

What Is the "Right" Price?

Communist countries must depend upon capitalist nations for one particular product that their economic system does not generate — the price of things. Prices are generally higher in Communist countries but they are based on competitive prices in free markets. Where else can you find the value of material items?

The prices you pay for goods in a competitive individual enterprise system in effect create the goods you want to buy.

Ideally, the right price is one that holds supply and demand in exact balance. The price goes up when demand is greater than supply and regulates consumption more efficiently and less expensively to the buyer than any legislation and rationing you can devise. The increased price stimulates production to meet demand and brings the two into balance again. When supply is heavier than demand, a balance can be sought by lowering price to encourage a greater demand.

This is the simple theory of price function.

In the petroleum industry the theory still holds although, like many industries, it is surrounded and mixed with many special circumstances that call for specialists to understand.

The principle of rising prices to meet rising demand held in the situation where Europe needed supplies to replace Middle East oil. Without an increased price, there was slight hope that U. S. operators could provide for an emergency in Western Europe and keep a margin of producing capacity for a possible future crisis. Increased prices penetrate every operation to produce more, to use ingenious methods of transportation. Thousands of minds are concentrated on one objective — to get more oil to Europe.

The oil industry covers areas and time factors that no other industry has to face. The price increase that the British press attacked in January, 1957, may well produce the supplies that will save her and us and the rest of the free world in 1967.

In the early 30's the Interstate Oil Compact Commission set up provisions for equitable and efficient production, which is sometimes confused with setting supply limits. Essentially it is a technique that allows producers to use free underground storage on an equal basis.

Without the Compact the U. S. could not have fueled the Allied forces in World War II — without U. S. oil there would have been no victory. Without its long-range plans of exploration and conservation stimulated by price increases now, the industry cannot meet demands 10 to 20 years from today.

Price balances the scales to assure that vital supply meets urgent demand whenever it comes.

Ernestine Adams

PRICING BY FIAT

The petroleum industry's prices, always lagging behind others in inflation periods, are always getting investigated. In 1955 a United Nations Economic Committee decided that so-called international oil companies were too high on prices of Middle East oil for Europe. They wanted a cost-plus price for Middle East oil agreed upon by governments and suppliers.

Some of those companies had spent $40 million in Ecuador, $30 million in New Guinea, and many more millions in other parts of the world without finding oil to sell. After all, it cost $62 million to locate the first barrel of oil in Iraq. The money has to come from where you find the stuff.

The same situation exists in the U. S. where natural gas producers are at present under a utility pricing system which the U.N. Economic Committee would doubtless approve. Dry holes don't count. You go for broke.

Win $25.. write a Joe Roughneck cartoon line

Joe Roughneck is a sort of composite spirit of the men who drill for and produce vital oil. You probably know dozens of Joe Roughnecks . . . men on rigs in the field and men running progressive companies. Lone Star is dedicated to supplying them with API casing, tubing and line pipe.

Drawing on your own experience and things you've heard . . . send us a Joe Roughneck cartoon line and suggestion for illustration. For every one that we use in our ads, we'll pay $25. Send in your oil field smile lines now. In case the same line is sent in by more than one person, the one with the earliest postmark will collect. All entries become the property of Lone Star Steel. Our employees, our advertising agency and their families may not compete.

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Any way you look at it—

This Model OWL-50 two-stage unit was first set up as a single-stage unit for gas lifting one well near Refugio, Texas . . . then later moved to the Hobson Field and changed over to two-stage operation. It now handles about 250,000 cubic foot of gas per day with approximately 30 psi intake and 580 psi discharge pressures as part of a 15-well gas-lift system.

Lorain OWL Direct Connected Compressors

...give you extra advantages in the 20-50 hp range

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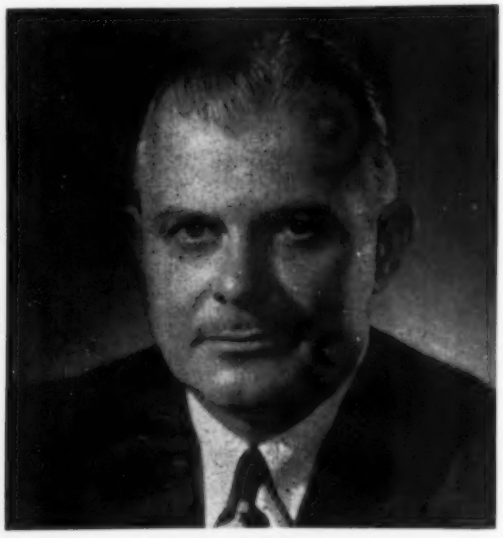


• **K. S. ADAMS**
Chairman of the Board
Phillips Petroleum Company

BEHIND Phillips Petroleum Company's standing as the fastest growing of the nation's 10 largest oil companies are two paramount characteristics — foresight and boldness. So it is no whim of fate that the epitome of these traits is found in K. S. Adams, the company's board chairman and chief executive officer and Phillips forceful leader during its period of greatest growth.

The impressive mark of "Boots" Adams, as he is known to his many friends, has been felt by Phillips almost since the company's founding by Frank Phillips in 1917. As a strapping, six-foot Kansas university basketball star, Kenneth Stanley Adams joined Phillips at its Bartlesville, Oklahoma, headquarters in 1920. Within months he organized an employee basketball team — which has since become world famous — and began learning the oil business with a driving energy and enthusiasm he has never been without.

Starting as a warehouse clerk in the company's production department, he transferred in 1926 to the accounting department and from there to the treasury department.

Four years later, Frank Phillips chose young Adams as his assistant. In 1938, "Boots" at age 38 was elected president. Upon Phillips' retirement, Adams became the chief executive officer of the company and later, in 1951 was elected chairman of the board.

Such are the bare facts of the meteoric rise of the company's top official. But behind them lay numerous examples of his decisive leadership and vision.

When most natural gas was still being flared as waste, Adams recognized its potential value and set about acquiring Phillips gas reserves, now among the largest in the industry. Such foresight also led to Phillips position as the world's largest producer of natural gas liquids, and its top ranking in the booming field of petrochemicals.

In the late twenties, when the company launched its marketing, the rising young executive was given the assignment of acquiring sales outlets for Phillips branded products. Putting in about 20 hours a day, he successfully completed this task during the depression when most operators were pulling in their horns.

In face of divergent opinion, "Boots" was convinced that the Oklahoma City field extended under the city. He bought up additional leases and waged a public opinion campaign that led to a vote of "yes" by the citizens to permit oil drilling in the city. Result: Phillips walked off with a major share of this rich field.

With a solid foundation laid, K. S. Adams directed the building of a huge expansion and diversification program that has quadrupled the company's assets in the 10 postwar years. Today Phillips products range from gasoline, motor oil and other conventional products to fertilizers, synthetic rubbers, and the revolutionary Marlex polyethylene plastics. It is intensively active in atomic energy and rocket fuels.

Phillips chairman is a masterful appraiser of management material and instills in those around him much of his own dynamic enthusiasm. The company's top executive team of Chairman Adams, Paul Endacott, president; Stanley Learned, chairman of the executive committee, and W. W. Keeler, executive vice president, is esteemed throughout the industry for its management record.

One would think that basic policy planning and direction of Phillips far-flung, widely diversified activities would tire a man even with "Boots" Adams' prodigious energy. Not so. His personal interests and contributions to industry and community are many and varied.

He has long been a leader in bringing about sound oil and gas conservation practices. His forceful fight against excessive government control and his promotion of more thorough grounding of young people in the principles of the American business system have won many plaudits.

In 1952, the Oklahoma American Legion named him the state's outstanding member. Drury College awarded him the honorary doctor of laws degree in 1955.

Adams is a dedicated supporter of improved ranching and farming practices. He oversees experiments in better techniques and soil improvements on his 32,000-acre Osage County ranch, following typical Adams upgrading philosophy with the aim of feeding one cow on three acres instead of 10 acres. He goes after similar aims with prize-winning dairy cattle on his model 1500-acre Ken-Ada Farms near Bartlesville.

At Ken-Ada, where he lives with his charming wife, the former Dorothy Glynn Stephens, and the five youngest of his seven children, he enjoys his chief off-the-job interest — that of a devoted family man — with the zest that is his hallmark.

"Boots" Adams embodies the dynamic qualities which forged the oil industry and the American free enterprise system. It will take men of his stamp to protect and cultivate them in the challenging years ahead.

1000 BRINELL DURACASE TRIM...

Stops galling and erosion

Since the introduction of OIC's Duracase Trim, many forged steel valve specs are obsolete. This 13% chrome stainless steel trim with 1000 Brinell, case-hardened wedges and discs assures positive protection against even the simultaneous attack of the three valve-destroying agents—corrosion, erosion, galling.

OIC offers you a choice of two modern body-bonnet connections—union ring or bolted bonnet—on its entire forged steel gate, globe, angle, and check valve line.

In addition, gate valves offer a choice of standard-flow or high-flow body ports, both with 1000 Brinell wedges.

Step up your valve requirements to the modern high-quality standards reflected in OIC valves. Include OIC on your next specification.

For OIC forged steel valve specification literature, write for Forms No. 195 and 195-R.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

OIC VALVES | FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES

THE CONFERENCE TABLE

ELECTRONICS DEFINITION: *Democracy is a governmental system involving a high percentage of negative feedback around all stages of the system from input to output.*

They Put It on The Line

You won't want to miss what the "Engineer Expects of Management" or what "Management Expects of the Engineer." Both our authors — Engineer R. F. Parker and President Rockwell — dive into the question and come up with worthwhile observations.

There are reports of the engineer shortage and the dissatisfaction of the engineer with salaries and status. A recent analysis of a Northwestern University survey shows the salary of engineers reaches an early plateau. According to this, engineers have the highest starting salary but 10 years after graduation their salary is the lowest paid to college graduates.

National Industrial Conference Board finds dissatisfaction is spreading, particularly among engineers on the job six or seven years. One result has been engineer unions. NICB reports 60,000 of the present 500,000 or more professional engineers are affiliated with the Engineers and Scientists of America, an independent union.

Two main causes are given for discontent: (1) Salary because the spread between their earnings and those of the skilled worker is too small and (2) status in companies where engineers claim management treats them the same as non-professional workers.

For a better understanding of a vital problem turn to Pages E-4 and E-5.

Nobody's Price-Happy — Hamon

The oil man, whether he is a Texas producer or a Boston fuel oil peddler, is a victim of inflationary pressures like any other businessman or householder, Jake L. Hamon, chairman of the board of the American Petroleum Institute, told the Independent Oil Men's Association of New England.

"Rising cost is a hair shirt that is as uncomfortable to us as anyone else. Yet when conditions forced the oil industry into general price adjustments to meet higher steel, labor, and other costs, we have been called stupid, greedy, and nominated for investigation.

"The industry will accept the responsibility for providing an abundant supply of oil, but it cannot operate outside the economic tides affecting the whole economy," Hamon said. "We believe that the American consumer's topmost interest is in having oil and gasoline. He does not want scarcity at an artificial or fictitious price."

Hamon pointed out that recent crude oil and oil product price increases did not seem to make anyone in the industry entirely happy. He said some refiners would have preferred to see an increase delayed and many crude producers thought the price change was too little and too late.

Hamon said crude buyers who have to look ahead for supplies found a declining trend in crude supplies. He continued:

"If today's crude prices are adequate — and we will know only through trial and error — they should stimulate production of much oil already found but uneconomic to produce. They should give a shot in the arm to exploratory effort. We need both."

Price adjustments brought forth "the usual blasts from professional critics of the industry," Hamon said, adding: "Long investigations in previous years have proved most of their charges or insinuations to be utterly without foundation. Unfortunately, their headline sprees do confuse and misinform a number of honest consumers."

He said that one of the least understood factors in the petroleum industry, thanks to these calamity howlers, is the operation of the oil and gas conservation laws in the oil-producing states.

He pointed out that if it were not for the backlog of productive capacity in Texas and other producing states, developed under such conservative practices, consumers on the Eastern seaboard as well as western Europe would be suffering a drastic shortage of oil this Winter.

"Some companies have been dissatisfied with recent production rates as being too restricted; a few months ago many buyers regarded the allowables as far too high," he said.

"No one in his right mind — producer or consumer — would want to return to the boom-and-bust days of the Twenties and Thirties, when fields played out in a year or so and millions of barrels of oil were left in the ground never to be recovered because there was no gas or water pressure to force the oil out."

*From Frontier Magazine.

Easy Living in 1975

It may be more difficult to manage business and industry in the future but living will be easy. Marlin G. Geiger, of W. R. Grace & Company, in speaking on "New Horizons in the Chemical Industry," describes it this way:

"Maybe in 1975, Joe Smith will live in an all-plastic fireproof house. In the morning he sprays a liquid on his face, wipes it off and the whiskers go with it. This is followed by a carbonated shower, and then he dresses in a perfectly and permanently creased suit of synthetic fibers.

"Joe's flavorful breakfast consists of three-year-old eggs in plastic shells, bacon just a bit younger, and synthetic milk. Real milk is too valuable. It is used to make a synthetic fiber from which Mrs. Smith's winter coat is made.

"Cars are plastic, lawns are mowed with a chemical vapor, and children will never know whooping cough, cavities or colds."

ECONOMIC SUMMARY

A quick review of economic changes.

	1956*	1955	% change
Gross National Products (Billion)	$412.0	$390.9	+5.4
National Income (Billion)	339.9	321.0	+4.0
Personal Income (Billion)	324.2	306.1	+5.9
Disposable Income (Billion)	285.8	270.6	+5.6
Consumer Spending (Billion)	265.3	254.0	+4.4
Crude Oil Production (MBPD)	7,148	6,790	+5.0
Oil Demand (MBPD)	9,289	8,806	+5.2
Industrial Products (Federal Reserve Bank)	147.0	139.0	+5.8
Steel Output (Million Tons)	115.4	117.0	−1.4
Autos & Trucks (Million Units)	6.9	9.2	−25.0
Housing Starts (Million Units)	1.1	1.3	−15.4
Carloading (Millions Cars)	38.0	37.9	+0.3
Purchasing Power of Dollar (1947-49=100)	85.4	87.2	−2.1
Consumer Credit (Billion)	40.2	36.2	+11.0
Gross Federal Debt (Billion)	276.7	280.8	−1.5
Corporate Net Income (Billion)	20.9	21.0	−0.5
Corporate Dividends (Billion)	12.5	11.2	+11.6

* Estimated

Two Good Omens

The beginning of the second Eisenhower administration has brought two encouraging announcements to the U. S. petroleum industry. First of these is the President's endorsement in his budget message of legislation to free natural gas producers from Federal Power Commission regulation. He said that he recognized the need for some type of legislation and he also recognized that competition was an essential factor in determining fair and reasonable prices for natural gas in the field. Said the President, "We must endeavor to make sure that there will be continued exploration and development of adequate field supplies of gas, and that producers' sale prices are arrived at fairly and competitively."

Some still believe that unless the President follows through on this recommendation, nothing will be done. The industry is still licking its wounds from the last veto and Congress does not seem greatly interested in such a controversial measure at the moment.

The second encouraging item is the comment of Treasury Secretary Humphrey about the 27½ percent depletion rates for oil. When asked if he thought the present rate was the proper one, he said that he didn't think anybody in the world could tell you whether 27½ or 27⅝ or some other fraction was exactly right. Stated the Secretary:

"If you have a figure which works out to bring about a proper objective that is about as close as you can come. The same thing is true with depreciation. You estimate the life of equipment at about so long and you do it the best you can. You keep revising that." He stated that in practice the present rate had worked out very well.

First Reports for 1956 Higher

First financial returns for 1956 are showing up in oil company reports. Here are some releases that have come over our desk.

Shell Oil earnings in 1956 rose to $135,800,000 compared to $125,532,000 the previous year.

Continental Oil Company expects earnings in excess of $5 a common share for 1956, up from $4.75 in 1955. Conoco's outlay in 1956 for exploration and development of new production and for construction of new facilities ran between $115 and $125 million. A two-for-one stock split is scheduled for Conoco stock.

Pure Oil Company will have a larger net income in 1956 than the $4.05 a share reported for 1955. Capital expenditures were 5 percent above the $43 million for 1955.

Suntide Refining earned $1.66 per share in 1956 as compared with $0.52 in 1955. Gross revenues were also much improved, $79 million in 1956 and $62 million in 1955.

Woodley Petroleum Company per share earnings in 1956 are estimated at around $2.75 on record gross income of nearly $6 million. This is up from $1.80 in 1955 on sales of $4.5 million.

Texas Gulf Producing Company reported a slight decrease in 1956 from its net income of $1.72 a share in 1955.

Ashland Oil and Refining Company earned $0.69 per share in 1956 as compared to $0.58 in 1955. These were on sales of $79 million and $72 million, respectively.

Frontier Refining Company reports for the first six months in its fiscal year which ended November 30, an income per share of $0.85 compared to $0.45 in 1955. This is on a gross in 1956 of $16 million and in 1955 of $13 million.

Imperial Oil, Ltd., reported record earnings and sales for 1956. For nine months ending September 30, the company had a net of $1.70 a share up from $1.42 a share. Capital expenditures of Imperial in 1957 will probably exceed the 1956 level of $15 million.

Superior Oil Company in the three months ending November 30, the first quarter of its current fiscal year, earned $10.27 a capital share, a large increase over the $2.48 a share in the like period in 1955.

Sinclair Oil Corporation estimates its 1956 profits at $6.17 a share up from $6.01 a share last year. Net income for 1956 is about $91 million, a new record, and 13 percent more than the profits reported for 1955.

Monterey Oil Company gross income for the three months ended November 30 amounted to $4,785,413 compared to $4,487,687 for the like period a year ago. Net income was $367,845 compared with $328,448.

Union Oil and Gas Corporation of Louisiana expects to report 1956 about equal to the $1.71 a share earned in 1955. Capital and exploration expenditures in 1956 were about $2 million over the $14,379,000 spent in 1955.

Nortex Oil & Gas Company net income plus write-offs rose to $750,000 from $496,000. A 4 percent stock dividend this year is planned to be continued annually.

TXL Oil Corporation's net income for the fiscal year ended November 30, is expected to approximate $0.67 per share. This compares with net earnings of $0.54 per share for 1955.

Socony Mobil Oil Company earnings in 1956 were estimated at $250 million or $5.70 per share. In 1955 the earnings were $208 million or $4.76 a share.

Texas Pacific Coal and Oil Company earnings for 1956, estimated to be approximately $2.00 per share, will be slightly below the $2.21 per share earned in 1955. Dividend payments, however, in 1956 were highest in the company's history.

Sunray Mid-Continent Oil Company net income for 1956 amounted to approximately $43,500,000. This compares with net earnings of $39,471,000 for 1955.

Report on Italian Company

SNAM (Natural Gas Pipe Line Company) has recently published a history and a description of its present operations which is one of the handsomest books we have seen. The Societa Nazionale Metanodotti was founded in October, 1941, for the purpose of construction and development of gas pipelines and sale of natural gas. One of its founders and now its majority holder is the Italian state-owned general petroleum agency.

The book tells a brief and effective story of natural gas in Italy with many pictures, maps and graphs. Pipelines are always photogenic and these are especially attractive with the lovely Italian scenery. River crossings have unusual treatment and make beautiful pictures. A large, thin volume, we don't know whether it is available or not. If you would like to have a copy, my suggestion would be that you write Dott. Ing. Enrico Mattei, Presidente, Societa Nazionale Metanodotti, Milano-Corso Venezia, 16, Italy.

Readin' and Writin'

When General Electric asked 13,000 of its college graduates what was the most valuable course to study in college, the company got a surprising answer, or maybe not so much so when you think about it a bit. From the standpoint of success in business and enjoyment of leisure time, college graduates thought English was their most important subject.

HIGHLIGHTS ★ ★ ★

Digest of News and Comment

Bulk of Kansas mineral wealth is in the oil and gas industry, reports the Kansas Geological survey. Crude oil produced in 1956 was valued at $351,000,000; natural gas contributed $58,000,000 to the state's economy; natural gasoline and liquified petroleum gases worth was estimated at $11,000,000. Coal, fourth ranking mineral in Kansas, accounted for a production value of $4,000,000 in 1956.

★ ★ ★

American Liberty Oil Company, Dallas, Texas, has been purchased in a recent move by American Petrofina, Inc., U. S. affiliate of the Belgian firm of Compagnie Financiere Belge des Petroles. All major assets of American Liberty were traded for cash and common stock estimated at more than $35,000,000. Included in the sale were oil reserves estimated at 14,000,000 bbl, a 16,000 bbl per day refinery at Mount Pleasant, Texas, 165 miles of crude lines, some 400 retail outlets for Amlico products, and 800,000 acres of undeveloped leases in Texas, New Mexico, Louisiana, Wyoming, Utah, Mississippi and Montana.

★ ★ ★

Gross national product reached a record $412 billion in 1956, reports Commerce Secretary Weeks in his year-end economic review. This $21 billion increase over 1955 represents a 5 percent advance. Weeks, in a forecast for this year, indicated that the 1957 rate of expansion may not be as fast as that of 1956, but "barring grave emergency, the economy as a whole should set new records."

★ ★ ★

Steel consumption may set new high marks in the first six months of 1957, predicts Roger M. Blough, chairman of United States Steel Corporation. Pattern of steel demand and production will result in a high level industry operating rate, with output probably higher in the first half of the year than in the last, he said. Oil and gas drilling activity will continue to increase, and U. S. shipyards will be straining to meet demands in merchant shipping—especially for oil tankers. "It seems likely," he stated, "that the industry's plans will continue to expand beyond the 143,000,000 ton total projected by the end of 1958."

★ ★ ★

Oil industry in Argentina will be developed only as a government monopoly—without private concessions, a new declaration cites. Government issued its statement along with an order to the nation's Central Bank to turn over $11,000,000 in foreign exchange to buy needed oil equipment and expand production. This latest declaration shades remarks made in December by the Argentine president, indicating that a departure from the oil monopoly plan might be forthcoming.

★ ★ ★

U. S. petroleum output can be increased to 9,000,000 bbl per day if necessary, reports Secretary of Interior Fred A. Seaton. The estimate is a conclusion drawn from special studies made for Seaton's department by oil industry personnel. Salient conclusions of the studies are: Not enough facilities to transport such amounts of crude oil—this includes all normal transportation systems, including pipelines, barges, and tank cars falling short of production by 1,000,000 bbl per day.

★ ★ ★

Second Cuban Congress on Petroleum, to be held in May, will be presided over by Dr. Alberto Diaz Masvidal, president of Petroleo Cruz Verde, S. A., a subsidiary of Consolidated Cuban Petroleum Corporation, and a member of the Cuban government economic board. An organizing committee, composed of American and Cuban oilmen and bankers, are to finance the Congress, under the sponsorship of the Cuban oil industry.

★ ★ ★

Texas Oil and Gas, new edition of the reference booklet published by Texas Mid-Continent Oil & Gas Association, has now been released. Contained in the colorful 48-page booklet are facts and figures covering past and present performance of Texas's largest industry—presented in stories, pictures, graphs, and statistical tables—primarily for the past 10 years of operations. Distribution is being made to educational institutions, teachers, business men, the press and "interested" individuals.

★ ★ ★

Tax aid through rapid write-offs has been written off for producers of aviation fuels, as well as five other industries. Deletion of this phase of the refining industry was in keeping the fast amortization policy for industries "connected with the nation's defense program." Others stricken from the tax aid list were producers of heavy steel plate, titanium melting and processing industries, commercial airlines and producers of taconite ore.

Oil and gas rights on some 16,000,000 acres of land in western states may be affected by a recent court ruling in Colorado. Union Pacific Railroad has won oil and gas rights to 160 acres of northeast Colorado land through a district court ruling that oil and gas are legally considered to be minerals. Union Pacific, like other railroads, has through the years sold much of its right-of-way lands to finance construction, but retaining mineral rights. In another recent case in Denver, a U. S. Circuit Court of Appeals has upheld ownership of oil and gas rights for Union Pacific on 40,000 acres in Adams County, Colorado.

★ ★ ★

U. S. crude oil exports will see a 14-fold increase during the first quarter of 1957, the Department of Interior predicts. The 1957 export forecast sets the rate of outbound crude at 433,000 bbl per day through March and 242,000 bbl per day from April through June. These exports compare with 30,000 bbl per day in the same periods of 1956. Government has promised Europe up to 500,000 bbl of crude daily during the winter months while the Suez Canal is closed.

★ ★ ★

Crude oil is Canada's most valuable mineral now being produced, according to that country's Bureau of Statistics. Production of oil produced in 1956 was $401,800,000; 1955 value was $305,640,036. Copper production ranked second, nickel third, and iron fourth. Total Canadian mineral output in 1956 was set at $2,067,699,096.

Annual Index for 1956 *The Petroleum Engineer*

The editorial index of articles published in all editions of *The Petroleum Engineer* during 1956 is now available.

Subscribers wishing to receive a free copy should write to this magazine, P. O. Box 1589, Dallas, Texas.

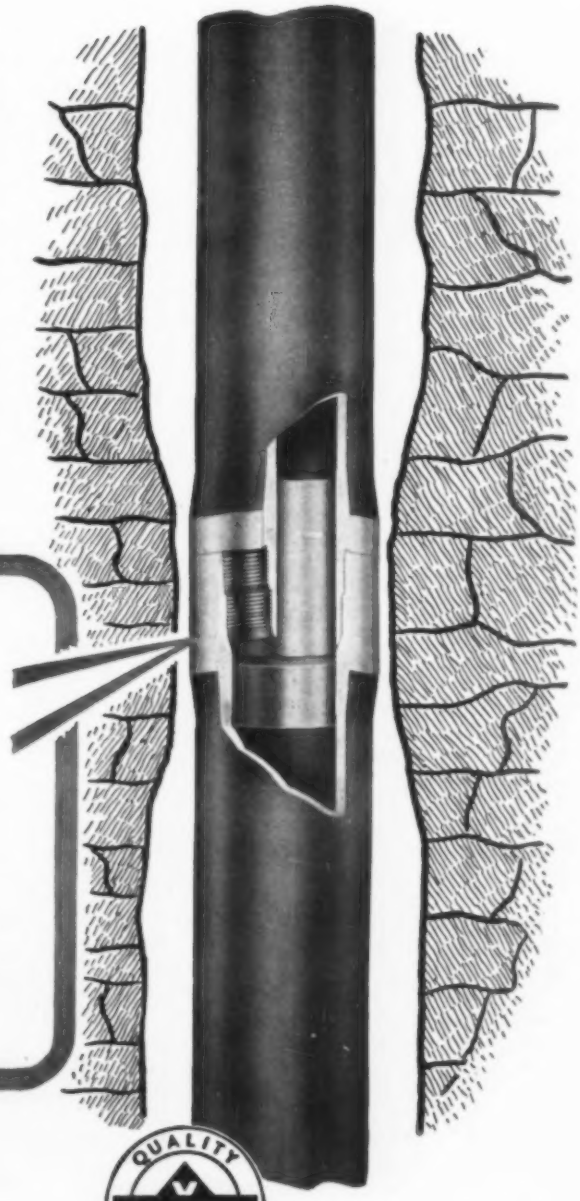
Please state company position and don't forget to include your address.

YOUNGSTOWN'S *SPEEDTITE*® CASING

Provides Greater Clearance
--Without Sacrificing Joint Strength

Progressive drillers recognize the importance of better clearance for engineering their casing strings more economically. They also realize the advantages of having higher strength joints for supporting the longer casing strings required for today's deepest wells. So, to get both these production features they specify Speedtite. They know there is **never** any sacrifice of joint strength for clearance because of Speedtite's special upset and double-step threading. Why not make it your specification—for lowered drilling costs and increased efficiency in the field.

Speedtite is busy on-the-job from off-shore drilling sites to the deepest wells in the Southwestern oil fields. Why not let your Youngstown representative show the many ways this modern casing can increase the efficiency of your operations?



Put These Speedtite Advantages to Work on Your Wells, Today

Speedtite's two-step thread provides faster make-up which:

- Reduces running time
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Speedtite's smaller joint OD (as compared to coupling on T & C casing), permits greater clearance which:

- Affords low friction running in the hole
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Speedtite's high joint efficiency provides maximum safety factors in tension with minimum pipe weights.

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Manufacturers of Carbon, Alloy and Yoloy Steel

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Crude oil price hikes, that spread through all Mid-Continent, Southwestern and Western states in January appear to be leveling off. The increases ranged from 10 to 35 cents per barrel on most crudes, although the higher marks, first set by Humble Oil and Refining Company, shifted downward in most Southwestern states to a 25-cent increase on 39 deg oil.

Following the complete round of crude hikes, posted by domestic purchasers, were increases averaging 18 cents per barrel by Canadian companies, explaining the difference to be due to "current exchange" premium enjoyed by the Canadian dollar. Venezuelan crudes have been increased in value 5 to 30 cents per barrel, to complete the revised crude price picture in the Western Hemisphere.

★ ★ ★

Consumer prices on oil prod- ucts, have now been increased in 35 states, as a result of higher prices being paid for crude. Affected products include gasoline, kerosine, heating fuel oil, heavy industrial fuels and diesel oil. Products increases have just about broken even in most areas, but gasoline price increases are reportedly "hardly holding the line," and in some regions are decreasing because of excessive stocks.

★ ★ ★

Western Europe fuel oil stocks will drop to about three weeks' supply by mid-February unless more oil is received, says J. P. Berkin, president of the European Industry's Emergency Group. Berkin is urging that the U. S. expand its oil shipments to Europe, and has pushed for quick reopening of the Syrian pipeline of Iraq Petroleum Company.

★ ★ ★

When and if the U. S. looks northward to meet its demand for oil, Canada will be ready, says Gordon Fox, manager of the Canadian Bank of Commerce at Calgary, speaking before an AIME group in San Francisco, California. Fox says that "half of the world's oil reserves lie in the Athabasca oil sands of Alberta," and that gas will be available in abundance from the Peace River block in the same province.

★ ★ ★

Prices on steel pipe exceeding 14-in. diameter have been increased 3½ percent by most manufacturers. U. S. Steel, in hiking its prices, said that boosts were result of extra charges for carbon structural shapes, amounting to 4½ percent, and carbon plate, 5½ percent.

Stanolind Oil and Gas Com- pany, Tulsa, Oklahoma, has taken a new name — Pan American Petroleum Corporation. Change became effective February 1. Two reasons were given: (1) To eliminate possibility of confusion with similarly named companies, and (2) to give the firm "a name more indicative of the geographical extent of its operations." The change is one of corporate name only, says President E. F. Bullard.

★ ★ ★

Telegrams to President Eisen- hower and several congressmen, sent from the Texas Service Stations Association, Austin, recently warned that industry operations have led to excessive gasoline stocks that in turn would cause a nationwide gasoline price war by spring. Many industry spokesmen predict that 1-cent hikes following recent crude hikes could not last, and that "sloppy" price structure would continue.

★ ★ ★

$10 billion highway expendi- tures annually are to be expected when the new road building program hits its peak. So says Harmon S. Eberhard, president of Caterpillar Tractor Company, speaking recently before an American Bankers Association credit conference in Chicago.

★ ★ ★

Motor fuel taxes in 1956 are expected to reach an all-time peak of $4 billion when all reports are in, American Petroleum Industries committee asserts. Total receipts by the federal government will be $1.3 billion. State taxes are expected to be $2.7 billion. Combined state and federal gasoline taxes first passed $1 billion in 1939, $2 billion in 1950.

Unprecedented growth in the gas utility and pipeline industry for the next 10 years has been forecast by American Gas Association. It predicts the industry's net income will be in excess of $1 billion a year by 1965. This anticipated increase would represent a 63 percent gain from last year's estimated $630,000,000 and a 500 percent increase from $201,000,000 in 1946.

★ ★ ★

New federal anti-pollution law has been given its first test in January before a joint federal and state hearing in Homer, Louisiana. Several oil wells in Arkansas are involved in the case, with charges of fouling waters of the Corney Creek drainage system in Louisiana. The group has power to give a Public Health Service stoppage order, which, if not obeyed, can lead to a Justice Department injunction.

★ ★ ★

Soap is slipping as man's prin- cipal cleaner, having lost its crown to oil-based detergents. Developed less than 20 years ago, synthetic detergents now account for almost two-thirds of all cleaning products sold, pushing aside conventional soaps used for over 2000 years.

★ ★ ★

Two Oklahoma-based oil companies are relocating in Texas. Frankfort Oil Company, Bartlesville, moved its offices to Dallas, Toklan Oil Corporation moved from its old offices in Tulsa to take a Houston address. Toklan officials move was blamed on "stringent allowables" in Oklahoma that have "drastically curtailed income." About 40 percent of Toklan stock was recently purchased by Houston Oilman Cecil W. Hagen.

Bulk oil and gasoline problems are being solved by the Army Transportation Corps by a new device called the "Rolling Fluid Transporter." Component parts of the transporter are a series of collapsible fabric cylinders, each with a capacity of 500 gal of fuel, an axle and towing yoke. The cylinders are easily loaded without cargo space loss and lifting problem. Shown here is 3000 gal of fuel being towed by an Army tracked vehicle at a Thule, Greenland, Arctic icecap base. The new method is particularly adaptable to off-the-road use in arctic, desert, and marshy terrain.

Good Wells Make Good News

These authentic case histories from various sections of the country attest to the fact that ACID PETROFRAC® is a real well saver! Acid Petrofrac is a Dowell fracturing service that combines acidizing and fracturing benefits.

- ***Barber County, Kansas***—(New well, gas) Operator drilled at the west end of Hardtner field. Found only three feet of the productive Mississippi lime at 4,623-26 feet. Well tested only a show of gas.

  After an acid treatment, a 6,000-gallon jelled-crude treatment, and another acid treatment, production was only 1,050,000 cubic feet per day. A 20,000-gallon treatment using Acid Petrofrac, with 20,000 pounds of sand, resulted in an open flow potential of 7,150,000 cubic feet per day.

- ***Andrews County, West Texas***—(New well) Drilled as an extension to the Fullerton field and completed in Clearfork dolomitic limestone (6,800-7,080 feet). Well showed no production on drill stem test and little production after a 2,000-gallon acid treatment. After treatment with Acid Petrofrac using 15,000 gallons of fluid and 15,000 pounds of sand—down tubing and casing at 15 barrels per minute—well tested 419 barrels per day.

- ***Fremont County, Wyoming***—(Old well, new zone) A well in the Shelton Dome field had depleted the lower zone. Before plugging, it was decided to give the Embar lime at 6,360 feet an acid-base fracture treatment. (This zone had been acidized and plugged in 1945.) Dowell fractured the well with Acid Petrofrac, using 5,000 gallons of fluid without sand. Well then flowed 21 barrels of oil per hour.

- ***Harris County, Texas***—(New well) Completed in Yegua shaley sandstone of Rankin field. Perforated from 7,870 to 7,916 feet. Before Acid Petrofrac, well tested only a show of oil and gas. After 9,000-gallon frac treatment with 20,000 lbs. of sand and 250 gallons of temporary plug (Fixafrac*), well swabbed 50 barrels of oil per day.

For fracturing formations that exhibit moderate to high solubility, Acid Petrofrac is unexcelled. In many instances it has given good results where all other treatments have failed.

For more information or service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write to Dowell Incorporated, Tulsa 1, Oklahoma.

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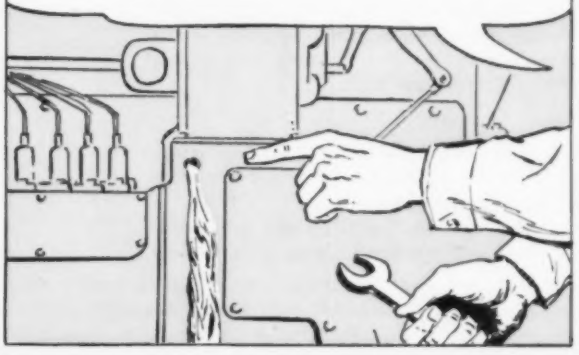
THE CASE OF
THE DANGEROUS DRUMS

THANKS FOR DROPPING BY, ART. I THINK I NEED A SET OF NEW INJECTION VALVES.

H-M-M-M, YOUR TRACTOR'S NOT VERY OLD. SHOULDN'T NEED VALVES.

SURE ACTS LIKE IT. THE ENGINE IS MISSING AND LOSING POWER!

BET YOUR TROUBLE'S RIGHT HERE, FRED ----LOOK AT THE WATER IN YOUR FUEL!



FRED, YOU NEED BETTER FUEL STORAGE FACILITIES. WATER AND RUST ACCUMULATE IN THESE DRUMS AND THERE'S NO EASY WAY TO DRAIN IT AWAY. JUST IN CASE THOSE VALVES ARE STICKY, I'LL BE GLAD TO CLEAN AND TEST THEM.

WE CLEANED THE VALVES, FRED. THEY CHECKED O.K. AND ARE READY TO GO.

THANKS, ART. YOU SAVED ME MONEY. BY THE WAY, I ORDERED A NEW FUEL STORAGE TANK TODAY!

CATERPILLAR*

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Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

Meetings

Feb. 5-7—**Reinforced Plastics Division of The Society of the Plastics Industry, Inc.,** 12th annual technical and management conference, Edgewater Beach Hotel, Chicago, Illinois.

Feb. 7-8—**Western Petroleum Refiners Association,** Gulf Coast regional technical-industrial relations meeting, Lamar Hotel, Houston, Texas.

Feb. 8-9—**ASTM,** symposium on composition of petroleum oil, committee D-2, Jung Hotel, New Orleans, Louisiana.

Feb. 13-15—**National Association of Corrosion Engineers,** 8th annual corrosion course for pipeliners, Mayo Hotel, Tulsa, Oklahoma.

Feb. 14-15—**AIME,** regional meeting, sponsored by University of Texas and Texas A&M College student chapters, Hogg Auditorium, University of Texas, Austin, Texas.

Feb. 15-16—**National Society of Professional Engineers,** spring meeting, Hotel Francis Marion, Charleston, South Carolina.

Feb. 19-20—**American Society of Civil Engineers,** pipe line division, Jackson, Mississippi.

Feb. 21—**National Industrial Conference Board,** meeting of board, Waldorf-Astoria Hotel, New York City.

Feb. 22—**Natural Gasoline Association of America,** Permian Basin regional meeting, Scharbauer Hotel, Midland, Texas.

Feb. 24-28—**American Institute of Mining, Metallurgical, and Petroleum Engineers,** annual meeting, Hotels Roosevelt and Jung, New Orleans, Louisiana.

Feb. 25-27—**American Association of Petroleum Geologists,** 7th annual meeting, Rainbow Randevu, Salt Lake City, Utah.

Feb. 26-27—**API Division of Marketing,** lubrication committee, Sheraton-Cadillac Hotel, Detroit, Michigan.

Feb. 27-28—**Gas Conditioning Institute,** Randall's Cafeteria, Liberal, Kansas.

March 6-8—**API Division of Production,** southwestern district, Statler Hilton Hotel, Dallas, Texas.

March 10-13—**American Institute of Chemical Engineers,** Greenbrier Hotel, White Sulphur Springs, Virginia.

March 10-16—**Engineers Joint Council,** second nuclear engineering and science congress, Convention Hall, Philadelphia, Pennsylvania.

March 11-15—**NACE,** 13th annual conference and exhibition, Kiel Auditorium, St. Louis, Missouri.

March 18-19—**Steel Founders' Society of America,** 55th annual meeting, Drake Hotel, Chicago, Illinois.

March 18-21—**Society of the Plastics Industry, Inc.,** annual national conference and Pacific Coast exposition, Hotel Biltmore, Los Angeles, California.

March 20-22—**API Division of Production,** southern district meeting, Washington Youree and Captain Shreve hotels, Shreveport, Louisiana.

March 25-27—**Western Petroleum Refiners Association,** 45th annual meeting, Hilton Hotel, San Antonio, Texas.

March 27-29—**American Power Conference,** Sherman Hotel, Chicago, Illinois.

April 1-4—**AAPG,** national convention, Kiel Auditorium, St. Louis, Missouri.

April 2-4—**Corrosion Control Short Course,** sponsored by Central Oklahoma Section of NACE and University of Oklahoma, University of Oklahoma Extension Study Center, Norman, Oklahoma.

Use low-cost

CONCENTRATED

BORASCU®

WEED KILLER

wherever weeds and grasses are a FIRE HAZARD!

Your "grassing" costs can drop as much as 80% when you use this weed killer! Savings in man-hours alone can be impressive when you consider that year-long results come from just one easy, DRY application of powerful Concentrated BORASCU. This granular, inorganic herbicide destroys most vegetation and prevents regrowth for long periods because it remains active in the root zone; satisfactorily meets all your requirements for safety.

NOTHING TO MIX
NO WATER TO HAUL
NONPOISONOUS
NONCORROSIVE TO FERROUS METALS

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PACIFIC COAST BORAX COMPANY DIVISION

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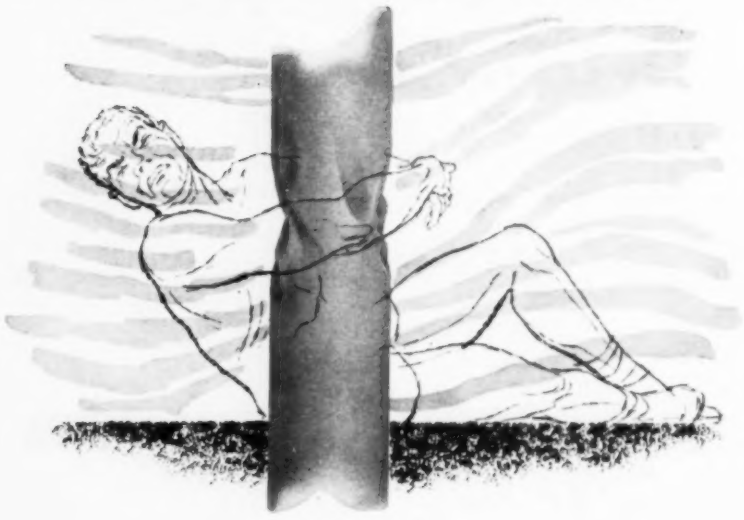
DISTRIBUTORS LOCATED THROUGHOUT OIL FIELDS OF U.S.A., CANADA, MEXICO, COLOMBIA, VENEZUELA.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

A-17

Some water-floods are

STRANGLING themselves!



That's not poetic license, but sober, frightening fact! For the water itself, in many floods, is the very thing that is slowly choking the flood to death. Algae and bacteria (particularly the sulfate-reducing bacteria), not removed by treatment and ordinary filtration, travel into the flood zone with the flood water; there, in the heat and darkness, they thrive and multiply, reducing the permeability almost as effectively as cement. Down goes the drive, up go pump pressures!

THE BRIGHTER SIDE!

But there's a happier story on floods where filtration with Dicalite filteraids is employed. So "sharp" is this filtration that algae and practically all bacteria are effectively removed before the flood water is pumped into the formation. Results? No formation blocking, as proved by the fact that pump pressures remain practically constant, month after month – sustained oil production because the water drive is operating at full efficiency.

LESS COST ... LESS SPACE ... PLUS PORTABILITY

Dicalite filtration of flood water requires less capital outlay and takes less space than do conventional sand filter systems. And, if desired, this more efficient system can be made completely portable, as is the case with several flood systems now operating, which are completely salvageable and movable from one location to another.

Write for complete information.

Dependable GLC GREAT LAKES Dicalite DIATOMACEOUS MATERIALS

DICALITE DIVISION • GREAT LAKES CARBON CORP., 612 SO. FLOWER ST., LOS ANGELES 17, CALIF.

April 7-10—**ASME,** instrument & Regulators Conference, Northwestern University, Chicago, Illinois.

April 8-9—**Industrial Accident Prevention Association,** annual conference, Royal York Hotel, Toronto, Canada.

April 8-10—**ASME,** spring meeting, Dinkler Tutwiler Hotel, Birmingham, Alabama.

April 8-10—**AIME,** open hearth and blast furnace conference, William Penn Hotel, Pittsburgh, Pennsylvania.

April 8-12—**American Welding Society,** Sheraton and Bellevue Stratford Hotels, Philadelphia, Pennsylvania.

April 10-12—**National Nuclear Instrumentation Conference,** Atlanta, Georgia.

April 10-12—**API Division of Production,** Mid-Continent district meeting, Mayo Hotel, Tulsa, Oklahoma.

April 11-13—**AIME,** Pacific Northwest regional conference, Portland, Oregon.

April 16-18—**National Petroleum Association,** 54th semi-annual meeting, Cleveland, Ohio.

April 22-25—**Canadian Institute of Mining & Metallurgy,** annual general meeting, Chateau Laurier, Ottawa, Ontario, Canada.

April 24-26—**API Division of Production,** Rocky Mountain district meeting, Buena Vista Hotel, Biloxi, Mississippi.

April 24-26—**Natural Gasoline Association of America,** 36th annual convention, Rice Hotel, Houston, Texas.

April 25-26—**API Board of Directors,** Dallas, Texas.

April 28-30—**Independent Petroleum Association of America,** midyear meeting, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

May 1-3—**API Division of Production,** Eastern district meeting, William Penn Hotel, Pittsburgh, Pennsylvania.

May 6-8—**API,** annual pipe line conference, Cleveland Hotel, Cleveland, Ohio.

May 6-8—**American Geophysical Union,** 38th annual meeting, Washington.

May 13-16—**API Division of Refining,** midyear meeting, Penn-Sheraton Hotel, Philadelphia, Pennsylvania.

May 16-17—**API Division of Production,** Pacific Coast district, Biltmore Hotel, Los Angeles, California.

May 19-22—**Texas Independent Producers and Royalty Owners Association,** 11th annual membership meeting, Galvez and Buccaneer hotels, Galveston, Texas.

May 20-22—**API Division of Marketing,** midyear meeting, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

May 20-24—**American Society for Testing Materials,** 5th conference on Mass Spectrometry, Commodore Hotel, New York City.

June 4-6—**Appalachian Underground Corrosion Short Course,** Morgantown, West Virginia.

June 9-14—**API Division of Production,** midyear committee conference, Muehlbach Hotel, Kansas City, Missouri.

June 17-20—**Interstate Oil Compact Commission,** midyear meeting, Canyon Hotel, Yellowstone National Park, Wyoming.

June 24-28—**American Institute of Electrical Engineers,** 1957 summer general, Montreal, Quebec, Canada.

Oct. 9-10—**Third Annual Computer Applications Symposium,** sponsored by Armour Research Foundation of Illinois Institute of Technology, Morrison Hotel, Chicago, Illinois.

Nov. 30-Dec. 1—**Executive Committee of Interstate Oil Compact Commission,** Wichita, Kansas.

New RIDGID 4PJ Geared Threader Is Now

*JAM-PROOF

*Automatically Stops Threading When Standard Length Thread Is Cut

Power drive threading is safe and easy with this new 4PJ—no more watching of either die stock or drive! 4PJ can't jam—drive pinion kicks out automatically when full thread is cut. Extra-easy to handle ...mistake-proof workholder, no bushings... fully enclosed gears... RIDGID most-for-your-money—Buy new 4PJ at your Supply House!

← RIDGID 400A Power Drive with Universal Drive Shaft operates 4PJ Threader on 4" pipe held in Tristand Chain Vise, all RIDGID products.

RIDGID
Work-Saver Pipe Tools

The Ridge Tool Company, Elyria, Ohio, U.S.A.

Quick as a cat... Quiet as a mouse

CHAPMAN
Tilting Disc Check Valve

There, in a nutshell, is the story of a Chapman Tilting Disc Check Valve . . . quick as a cat, quiet as a mouse. It's designed that way. It's built that way . . . for fast, sure, quiet action. Or, in other words, it's yours for best performance at lowest long-range operating costs.

With a Chapman Tilting Disc Check Valve, there's no noise, no vibration, no fluttering. There's no banging or slamming with damage to system or valve. There's no scraping or wearing of disc and seat. Your head loss or flow resistance is kept at a minimum.

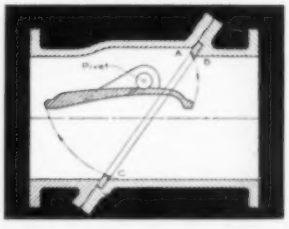
To put it briefly, with a Chapman Tilting Disc Check Valve, there's little or no maintenance even under severe operating conditions.

For Chapman Tilting Dise Check Valves in iron and steel . . . valves for handling fluids or gases under a wide range of pressures . . . valves for replacement or new piping systems . . . just check our Catalog 30-A. It's yours for the asking. Send for it now.

The CHAPMAN Valve Mfg. Company
INDIAN ORCHARD, MASSACHUSETTS

Never a Flutter, Never a Slam!

Designed and Built for Quiet Efficient Operation



In open position, specially designed "airfoil" disc balances perfectly. No vibration. No flutter. When flow subsides, disc drops quickly and quietly to a tight closed position. No jarring. No slamming. No damage to system or valve. Note enlarged area around disc to insure low flow resistance.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

As time goes by, Rust-Oleum long wear assures lower cost over-the-years protection!

Rust-Oleum is distinctive as your own fingerprint. Accept no substitute.

Rust-Oleum's *unusual* resistance to extremes in rust-producing conditions—from sun and salt water to humidity, moisture, fumes, and weathering—assures you of lasting beauty. Long wear made possible, because Rust-Oleum's *specially-processed fish oil vehicle* works down through the rust into the tiny, microscopic pores in bare metal to STOP RUST. Important savings are realized by applying Rust-Oleum 769 Damp-Proof Red Primer *over rusted metal* after scraping and wire-brushing to remove rust scale and loose rust—as costly surface preparations are usually eliminated. See how Rust-Oleum can save you money... in your plant, or your home. Prompt delivery from Industrial Distributor stocks. Write for illustrated literature with color charts.

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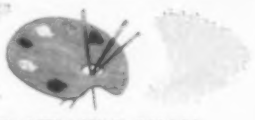
RUST-OLEUM®



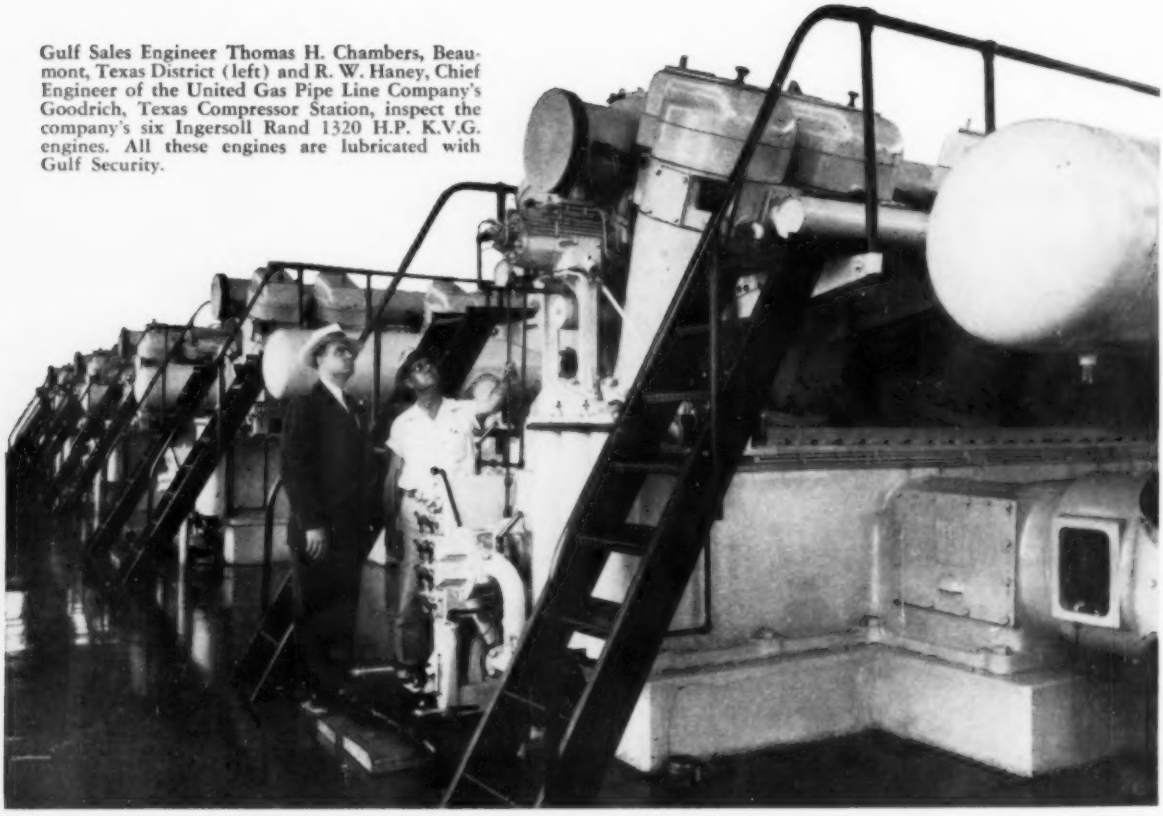
MANY ATTRACTIVE COLORS

Rust-Oleum finish coatings in Aluminum, White, Red, Gray, Green, Blue, Black, and Yellow provide double protection for tanks, machinery, girders, equipment, metal sash, wire fences, etc. Write for illustrated literature with color charts.

STOPS RUST!®

Rust-Oleum and Stops Rust are brand names and registered trademarks of the Rust-Oleum Corporation.

Radioactive tracing studies prove Rust-Oleum penetration through rust to bare metal.



Gulf Sales Engineer Thomas H. Chambers, Beaumont, Texas District (left) and R. W. Haney, Chief Engineer of the United Gas Pipe Line Company's Goodrich, Texas Compressor Station, inspect the company's six Ingersoll Rand 1320 H.P. K.V.G. engines. All these engines are lubricated with Gulf Security.

Lock out high maintenance costs in your gas transmission plants

with GULF SECURITY

Gulf Security's outstanding record in the lubrication of pipeline gas engine compressor units is your assurance of smooth, continuous operation. In scores of gas transmission plants this high quality straight mineral oil helps prevent operating troubles and contributes to low maintenance costs.

Gulf Security is a non-additive oil that does not cloud liquid filled lubricators of power cylinders, compressor cylinders, and packing glands. After years of operation with Gulf Security, cylinders and piston rings of both compressors and power assemblies show negligible wear, and its excellent oxidation stability helps prevent the formation of acid and resins in the crankcase system.

Make certain your units receive safe, effective lubrication protection—specify Gulf Security. And remember that Gulf provides the services of a trained, experienced petroleum expert—the Gulf Sales Engineer—to help you with any problem involving a petroleum product. Consult the telephone directory for the number of your nearest Gulf office.

GULF

Gulf Oil Corporation • Gulf Refining Company
1822 Gulf Building, Pittsburgh 30, Pa.

THE FINEST PETROLEUM PRODUCTS FOR ALL YOUR NEEDS

How International® Engines...help find, pump, and deliver oil and gas at low cost!

DRILLING...

$2.20 PER 10-HOUR DAY! That's the butane fuel cost of the International U-450 power unit driving this Wilson truck-mounted winch. Unit is owned by Vick Well Servicing Company, Kilgore, Texas.

3800-FOOT WELL IN 7 DAYS AND 8 HOURS! Powering a compressor which operates air tongs in a casing setting job at Huntington Beach, Calif., two International U-2A carbureted engines helped set this record for D. F. Bloom Co.

PUMPING...

NO FUEL COST PER HOUR! By using natural gas from the well, this International U-164 carbureted engine pays for itself in a very short time. It is one of 50 International engines pumping in an area less than half a city block, near Athens, Texas.

SO GOOD, HE OWNS 120! Joe Vanardel, master mechanic for L. B. Johnson Drilling Co., Kiefer, Okla., says "120 of these International pumping engines have proven to have low maintenance cost, long life between overhauls, and are very easy to work on."

PIPELINING...

86 MILES OF 30-INCH PIPE IN 60 DAYS! International carbureted engine on cleaning and priming unit stays well ahead of job to help Houston Contracting Company stay ahead of schedule. Job is located near Eudora, Ark.

100% INTERNATIONAL POWER! Long, low-cost, dependable life are the reasons why Fred Linneman, Inc., Denver, Colo., uses nothing but International power on his pipeline spread. Parson's Trenchliner, here, uses an International UD-14A diesel engine, cuts 1,600 feet per day.

Whatever your oil and gas power needs, from 10 to 200 hp, your International Power Unit Distributor or dealer can fill them quickly and dependably. You have your choice, too, of power units burning the fuel that's most easily and economically available to you.

A COMPLETE POWER PACKAGE INCLUDING: Crawler, Wheel, and Side Boom Tractors... Self-Propelled Scrapers and Bottom-Dumps... Crawler and Rubber-Tired Loaders... Off-Highway Trucks... Diesel and Carbureted Engines... Motor Trucks.

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180 North Michigan Avenue, Chicago 1, Illinois

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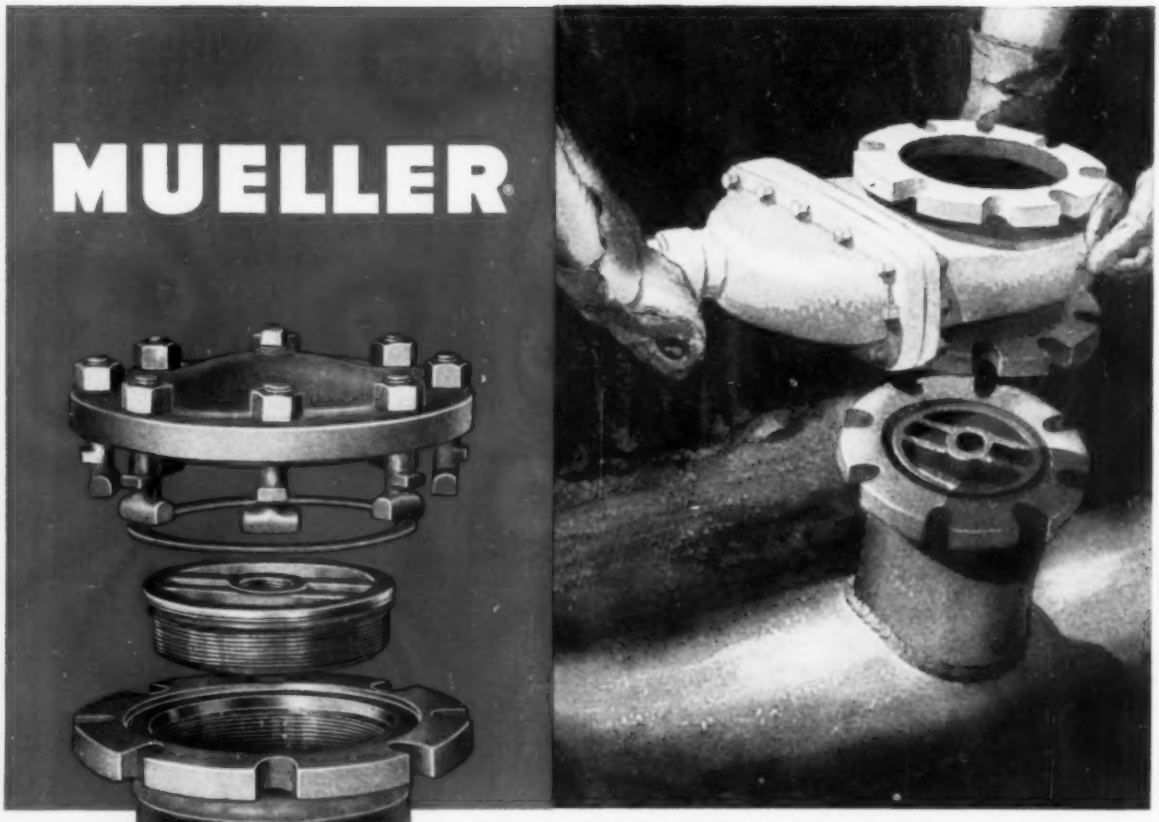

Money-saving Save-A-Valve Drilling Nipples are available with welding inlet for use with flanged valves in 4", 6" and 8" sizes...with welding or threaded inlet for use with threaded valves in ¾" through 3" sizes.

save money... save-a-valve!

You can safely recover expensive valves from temporary or semi-permanent connections with Mueller Save-A-Valve Drilling Nipples.

The NO-BLO® Completion Plug, on 4", 6", and 8" sizes, has "O" Ring Seal and pressure equalizing valve – effectively seals the connection while the gate valve is removed and the nipple is capped. The connection can be used again anytime.

Your Mueller Representative has complete specifications and information on how to save valves and save money with Mueller Save-A-Valve Drilling Nipples – call on him or write direct.

NO-BLO®

MUELLER CO. **DECATUR, ILL.**

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Since 1857

New Orthoflow Converter goes on-stream with CB&I-built Components

When American Oil Company's Orthoflow Fluid Catalytic Cracking unit went on stream in 1956 at their new 35,000-bbl. per day Yorktown, Virginia refinery, it contained a reactor, regenerator, vacuum tower, crude tower, absorber tower and catalyst hoppers fabricated by CB&I and furnished through M. W. Kellogg Company.

This is but one example of the way in which CB&I's complete designing, fabricating and erecting facilities enable them to create special or standard structures to meet the rigid specifications of the petroleum industry. When you plan steel plate structures, plan with CB&I. Write our nearest office for further information.

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STORAGE CAPACITY OF PIPE LINES, BARRELS

Length of line	Nominal diameter of line, inches								
	2	2½	3	4	5	6	8	10	12
10 feet	.042	.059	.091	.157	.247	.357	.633	1.01	1.42
20	.083	.118	.183	.315	.495	.715	1.27	2.02	2.84
30	.125	.178	.274	.472	.742	1.07	1.90	3.03	4.26
40	.166	.237	.366	.630	.990	1.43	2.53	4.04	5.68
50	.208	.296	.457	.787	1.24	1.79	3.16	5.05	7.10
60	.249	.355	.549	.945	1.48	2.14	3.80	6.05	8.52
70	.291	.415	.640	1.10	1.73	2.50	4.43	7.06	9.94
80	.332	.474	.732	1.26	1.98	2.86	5.06	8.07	11.36
90	.374	.533	.823	1.42	2.23	3.22	5.70	9.08	12.78
100	.415	.592	.914	1.57	2.47	3.57	6.33	10.09	14.20
110	.457	.651	1.01	1.73	2.72	3.93	6.96	11.10	15.62
120	.498	.711	1.10	1.89	2.97	4.29	7.59	12.11	17.04
130	.540	.770	1.19	2.05	3.22	4.65	8.22	13.12	18.46
140	.581	.829	1.28	2.20	3.46	5.00	8.86	14.13	19.88
150	.623	.888	1.37	2.36	3.71	5.36	9.49	15.14	21.30
160	.664	.948	1.46	2.52	3.96	5.72	10.12	16.15	22.72
170	.706	1.01	1.55	2.68	4.21	6.07	10.76	17.15	24.14
180	.747	1.07	1.65	2.83	4.45	6.43	11.39	18.16	25.56
190	.789	1.13	1.74	2.99	4.70	6.79	12.02	19.17	26.98
200	.830	1.18	1.83	3.15	4.95	7.15	12.66	20.18	28.40
300	1.25	1.78	2.74	4.72	7.42	10.72	18.98	30.27	42.60
400	1.66	2.37	3.66	6.30	9.90	14.29	25.31	40.36	56.80
500	2.08	2.96	4.57	7.87	12.37	17.87	31.64	50.46	71.00
1,000	4.15	5.92	9.14	15.75	24.74	35.73	63.28	100.91	141.99
1,500	6.23	8.88	13.72	23.62	37.12	53.60	94.92	151.37	212.99
2,000	8.30	11.84	18.29	31.49	49.49	71.47	126.56	201.82	283.99
2,500	10.38	14.80	22.86	39.36	61.86	89.33	158.20	252.28	354.98
3,000	12.45	17.77	27.43	47.24	74.23	107.20	189.84	302.73	425.98
3,500	14.53	20.73	32.00	55.11	86.61	125.07	221.48	353.19	496.98
4,000	16.60	23.69	36.58	62.98	98.98	142.93	253.12	403.64	567.97
4,500	18.68	26.65	41.15	70.86	111.35	160.80	284.76	454.10	638.97
5,000	20.75	29.61	45.72	78.73	123.72	178.67	316.40	504.55	709.97
1 mile	22	31	48	83	131	189	334	533	750
2	44	63	97	166	261	377	668	1,066	1,500
3	66	94	145	249	392	566	1,002	1,598	2,249
4	88	125	193	333	523	755	1,336	2,131	2,999
5	110	156	241	416	653	943	1,671	2,664	3,749
10			483	831	1,307	1,887	3,341	5,328	7,497
15			724	1,247	1,960	2,830	5,012	7,992	11,246
20			966	1,663	2,613	3,773	6,682	10,656	14,995
25				2,078	3,266	4,717	8,353	13,320	18,743
30				2,494	3,920	5,660	10,024	15,984	22,492
35				2,910	4,573	6,604	11,694	18,648	26,240
40				3,326	5,226	7,547	13,365	21,312	29,989
45				3,741	5,879	8,490	15,035	23,976	33,738
50				4,157	6,533	9,434	16,706	26,640	37,486
55				4,573	7,186	10,377	18,377	29,304	41,235
60				4,988	7,839	11,320	20,047	31,968	44,984
65				5,404	8,492	12,264	21,718	34,632	48,732

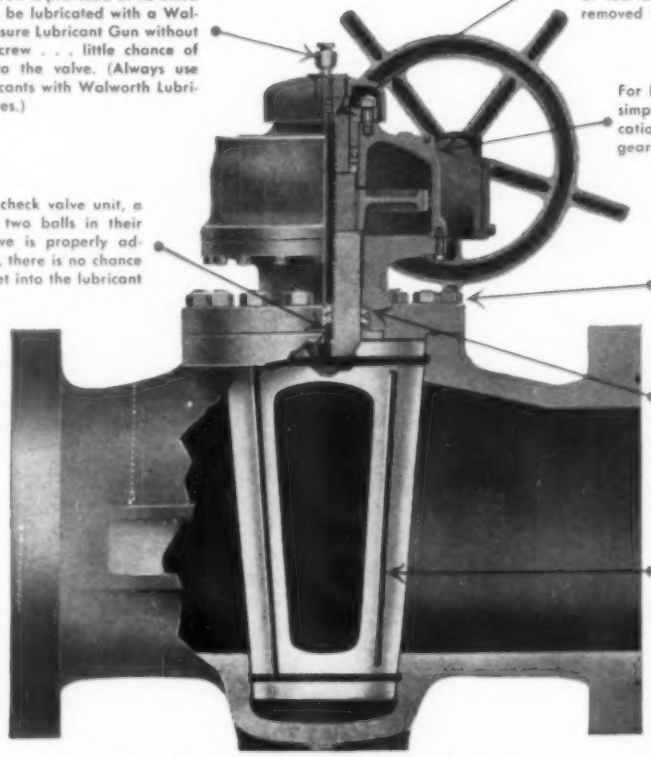
Let's get technical about WALWORTH LUBRICATED PLUG VALVES for pipeline service

Combination button-head lubricant fitting and lubricant screw is provided at no extra cost. Valves can be lubricated with a Walworth High Pressure Lubricant Gun without removing the screw . . . little chance of grit getting into the valve. (Always use Walworth Lubricants with Walworth Lubricated Plug Valves.)

An added safety feature in the form of a groove cut part way up side of the lubricant-fitting screw allows the operator to observe any tendency of lubricant to blow out before the screw is removed entirely.

For buried pipelines — yoke design permits simple attachment of handwheel and lubrication extensions without modifying the gearcase.

In the stainless steel check valve unit, a transverse pin holds two balls in their seats. When the valve is properly adjusted and lubricated, there is no chance for line pressure to get into the lubricant system.



Standard bolt threads, rather than fine threads, mean easy replacement of nuts and bolts from local stocks.

Two overlapping Teflon packing rings form an effective seal against possible leakage without "grabbing" the plug shank. Low breakout torque . . . plug turns easier. Packing serves only as a seal and is not used to hold the plug in its seat.

Lubricant grooves completely frame the port openings and encircle the plug at the top and bottom assuring a tight seal against leaks. Bottom circumferential groove is separate from, but connected with, the lubricant well.

Other Walworth Lubricated Plug Valves include Single Gland and Regular Gland types. Sizes to 30 inches. Pressures to 5000 psi. and for vacuum service.

Cutaway of a 24-inch Walworth Lubricated Plug Valve

Without exception, a Walworth Ball Bearing Lubricated Plug Valve is easier to operate and maintain than any other type of rotary-action, sealed valve available today for pipeline service. Design features pointed out here show just a few advantages of Walworth Ball Bearing Lubricated Plug Valves.

Many pipeline companies throughout the world use Walworth valves for handling gas, crude, and finished products. Investigate the line of Walworth valves for your own needs. See your Walworth Distributor, or write for literature: Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

Use pigs or scrapers?

Walworth Type 49 Cast Steel Gate Valves are designed on the throughport principle to permit passage of pigs and scrapers — may be installed without regard to flow direction. Sizes 2 to 30 inches inclusive. Ask for literature.

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SPECIFIC GRAVITY OF CAUSTIC SODA SOLUTIONS AT VARIOUS TEMPERATURES

Weight percent of NaOH	Temperature of solution										
	15° C. 59° F	18° C. 64.4° F.	20° C. 68° F	30° C. 86° F.	40° C. 104° F.	50° C. 122° F.	60° C. 140° F.	70° C. 158° F.	80° C. 176° F.	90° C. 194° F.	100° C. 212° F.
0	0.9992	0.9987	0.9983	0.9958	0.9924	0.9882	0.9833	0.9779	0.9719	0.9655	0.9586
1	1.0106	1.0100	1.0095	1.0069	1.0033	0.9990	0.9941	0.9884	0.9824	0.9760	0.9693
2	1.0220	1.0213	1.0207	1.0177	1.0139	1.0095	1.0045	0.9989	0.9929	0.9865	0.9797
3	1.0332	1.0324	1.0318	1.0285	1.0246	1.0201	1.0150	1.0094	1.0035	0.9970	0.9903
4	1.0444	1.0435	1.0428	1.0393	1.0352	1.0305	1.0254	1.0198	1.0139	1.0075	1.0009
5	1.0555	1.0545	1.0538	1.0501	1.0458	1.0412	1.0359	1.0302	1.0243	1.0179	1.0115
6	1.0667	1.0656	1.0648	1.0609	1.0564	1.0517	1.0463	1.0407	1.0347	1.0284	1.0220
7	1.0778	1.0766	1.0758	1.0717	1.0672	1.0623	1.0569	1.0513	1.0453	1.0390	1.0326
8	1.0889	1.0877	1.0869	1.0826	1.0780	1.0730	1.0676	1.0619	1.0560	1.0497	1.0432
9	1.1000	1.0987	1.0979	1.0934	1.0887	1.0836	1.0782	1.0725	1.0665	1.0602	1.0537
10	1.1111	1.1098	1.1089	1.1043	1.0995	1.0942	1.0889	1.0831	1.0771	1.0708	1.0643
11	1.1222	1.1208	1.1199	1.1152	1.1102	1.1050	1.0995	1.0937	1.0877	1.0814	1.0749
12	1.1333	1.1319	1.1309	1.1261	1.1210	1.1157	1.1101	1.1043	1.0983	1.0920	1.0855
13	1.1444	1.1429	1.1420	1.1370	1.1319	1.1265	1.1208	1.1150	1.1089	1.1026	1.0960
14	1.1554	1.1540	1.1530	1.1480	1.1428	1.1373	1.1316	1.1257	1.1195	1.1132	1.1066
15	1.1665	1.1650	1.1640	1.1590	1.1536	1.1480	1.1424	1.1364	1.1302	1.1238	1.1172
16	1.1776	1.1761	1.1751	1.1699	1.1645	1.1588	1.1531	1.1471	1.1408	1.1343	1.1277
17	1.1887	1.1871	1.1862	1.1808	1.1804	1.1696	1.1638	1.1578	1.1514	1.1450	1.1383
18	1.1997	1.1982	1.1972	1.1918	1.1963	1.1805	1.1746	1.1685	1.1621	1.1556	1.1489
19	1.2108	1.2092	1.2082	1.2027	1.2021	1.1912	1.1853	1.1792	1.1727	1.1662	1.1594
20	1.2218	1.2202	1.2191	1.2136	1.2079	1.2020	1.1960	1.1898	1.1833	1.1768	1.1700
21	1.2328	1.2312	1.2301	1.2295	1.2188	1.2128	1.2067	1.2004	1.1940	1.1874	1.1806
22	1.2439	1.2422	1.2411	1.2454	1.2296	1.2236	1.2174	1.2111	1.2046	1.1980	1.1912
23	1.2548	1.2532	1.2520	1.2512	1.2404	1.2344	1.2281	1.2218	1.2152	1.2086	1.2018
24	1.2658	1.2641	1.2629	1.2571	1.2512	1.2451	1.2388	1.2324	1.2259	1.2192	1.2124
25	1.2768	1.2750	1.2738	1.2680	1.2620	1.2558	1.2496	1.2431	1.2366	1.2298	1.2230
26	1.2877	1.2860	1.2848	1.2789	1.2728	1.2666	1.2603	1.2538	1.2472	1.2405	1.2336
27	1.2986	1.2968	1.2956	1.2896	1.2835	1.2772	1.2708	1.2644	1.2577	1.2510	1.2441
28	1.3094	1.3076	1.3064	1.3002	1.2942	1.2878	1.2814	1.2750	1.2682	1.2615	1.2546
29	1.3202	1.3183	1.3172	1.3110	1.3048	1.2984	1.2920	1.2854	1.2787	1.2720	1.2650
30	1.3309	1.3290	1.3279	1.3217	1.3154	1.3090	1.3025	1.2959	1.2892	1.2824	1.2755
31	1.3414	1.3396	1.3384	1.3322	1.3258	1.3194	1.3128	1.3063	1.2994	1.2926	1.2858
32	1.3520	1.3502	1.3490	1.3427	1.3362	1.3298	1.3232	1.3165	1.3097	1.3029	1.2960
33	1.3624	1.3605	1.3593	1.3530	1.3464	1.3400	1.3333	1.3266	1.3198	1.3130	1.3060
34	1.3728	1.3708	1.3696	1.3632	1.3566	1.3501	1.3434	1.3367	1.3299	1.3230	1.3161
35	1.3830	1.3810	1.3798	1.3734	1.3667	1.3602	1.3534	1.3467	1.3398	1.3330	1.3260
36	1.3933	1.3913	1.3900	1.3835	1.3768	1.3702	1.3634	1.3567	1.3498	1.3429	1.3360
37	1.4034	1.4014	1.4000	1.3935	1.3868	1.3801	1.3733	1.3665	1.3596	1.3528	1.3458
38	1.4135	1.4115	1.4101	1.4035	1.3967	1.3900	1.3832	1.3763	1.3695	1.3626	1.3556
39	1.4234	1.4214	1.4200	1.4134	1.4066	1.3998	1.3930	1.3860	1.3792	1.3723	1.3653
40	1.4334	1.4314	1.4300	1.4232	1.4164	1.4095	1.4027	1.3958	1.3889	1.3820	1.3750
41	1.4432	1.4411	1.4397	1.4328	1.4260	1.4191	1.4122	1.4053	1.3984	1.3914	1.3845
42	1.4529	1.4508	1.4494	1.4425	1.4356	1.4287	1.4217	1.4148	1.4079	1.4009	1.3940
43	1.4624	1.4604	1.4590	1.4520	1.4450	1.4381	1.4311	1.4242	1.4172	1.4102	1.4034
44	1.4720	1.4699	1.4685	1.4615	1.4545	1.4475	1.4405	1.4335	1.4266	1.4196	1.4127
45	1.4816	1.4794	1.4779	1.4710	1.4640	1.4569	1.4499	1.4429	1.4360	1.4290	1.4221
46	1.4911	1.4890	1.4873	1.4805	1.4734	1.4663	1.4593	1.4523	1.4454	1.4384	1.4315
47	1.5006	1.4985	1.4969	1.4900	1.4828	1.4757	1.4687	1.4617	1.4548	1.4478	1.4409
48	1.5102	1.5080	1.5065	1.4994	1.4922	1.4851	1.4781	1.4711	1.4641	1.4572	1.4503
49	1.5196	1.5174	1.5159	1.5088	1.5016	1.4944	1.4874	1.4804	1.4734	1.4666	1.4596
50	1.5290	1.5268	1.5253	1.5181	1.5109	1.5038	1.4967	1.4897	1.4827	1.4759	1.4690

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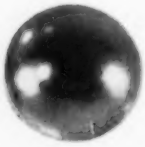

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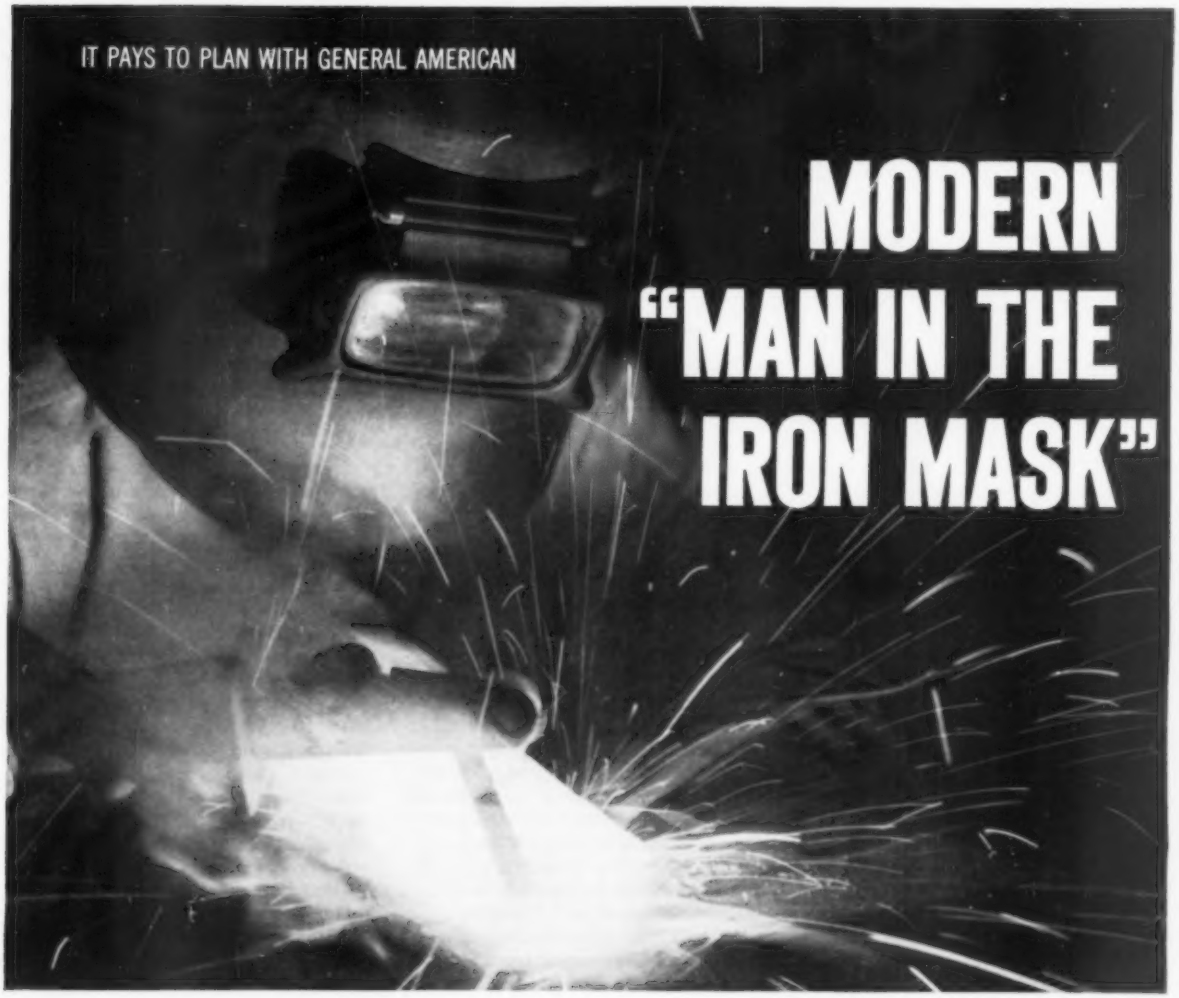

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Opportunity is what the engineer wants first -- opportunity in engineering and in management .... says Engineer Parker

What does the Engineer Expect of Management?

WHAT the engineer expects from management more than anything else is "opportunity." The engineer expects opportunity to advance, to produce, and to participate to the extent of his abilities and on an equal footing with others in the organization.

In addition to opportunity, the engineer expects recognition, respect and confidence. Recognition of accomplishments and respect for ability should be given to all who merit them. The engineer expects to be included. Confidence, like respect, must be earned. Continued confidence requires continued performance and the engineer expects to retain the confidence of management as long as he performs satisfactorily.

Opportunity

The engineer is a professional man and as such expects the opportunity to reach a level, both economic and social, with other professional men of similar age.

Unlike most other professional men, the engineer is more often an employee of a large or small company and as such is subject to the personnel policies of that organization. Unlike the doctor and the lawyer, he does not enjoy the same freedom in defining the limits of his specialty, in setting his pay scale and in establishing his office hours and working environment. Consulting engineers in private practice are obvious exceptions. Of course there are compensations for this lack of freedom in that the engineer does not rent and equip his office, pay his secretary and other assistants or worry too much about where the next bit of work is coming from.

The engineer who enters industry as an employee and remains there cannot expect to attain the freedom enjoyed by the brain surgeon or the independent attorney even though he may be every bit as skillful as the surgeon and as clever as the attorney. What he does feel entitled to, however, is the opportunity to progress through the various levels of his company to the level of top management — *if he is qualified.*

In some large corporations, top management always comes from the accounting department and there are no positions at this level outside management. In others, the purchasing department seems the best path to the top. I have in mind one example of each such company and in both cases the success of the company depends upon technology rather than skillful bookkeeping or clever and frugal buying. A young engineer entering the employ of either of these corporations does not have the opportunity equal to that of an accountant or a purchasing agent but he may not be able to see through the maze of the organization chart and discover that engineers seldom reach the stature of vice president. After putting in 10 years with the engineering department, he may be loath to give up his seniority and retirement benefits to seek employment elsewhere.

I would certainly oppose to the limit the adoption of a "seniority" system for advancement of engineers. Many holders of engineering degrees are, after 20 years, quite satisfactory junior engineers and no more. Certainly a mediocre man should not stand in the path of a really capable younger man with energy, ambition, and ability and he will be unable to do so for long unless protected by rules of seniority. It is possible, however, for an engineer with real management ability to be blocked from advancement by traditions and taboos which, like most traditions and taboos, have no sound basis.

There are also firms whose top management is made up almost exclusively of engineers. While engineers may be attracted by a policy which appears to afford access to top management positions, such a policy is unhealthy for the company. The same closed door policy which will discourage engineers in another company will make it difficult to attract really competent personnel managers, accountants, and purchasing agents. These skills are also needed and should be represented in management.

When one profession holds most of the positions of responsibility, the management of the company becomes unbalanced. Should a member of another profession gain power, there is also likely to be a wholesale reorganization which will hurt not only those individuals who are reclassified, but also the company particularly in its relationships with its business associates.

In many companies, there are no positions outside the management group at a level corresponding to, say,

TURN TO PAGE E-6

Representing the Engineer

R. F. Parker is a native of Texas and a graduate of Rice Institute, Houston. In addition to seven years of teaching mechanical engineering and four years in the U. S. Corps of Engineers, Parker has been engaged in the design and operation of a wide variety of installations including chemical, petroleum processing, food processing, and water treating plants and gas pipeline facilities.

He has been an independent consulting engineer and is now employed by Bechtel Corporation in San Francisco, California, as a supervising engineer in the Pipeline Division.

Parker has written a few previous papers on the design and construction of various plants. This is his first paper on the subject of Management.

Responsibility is the key trait for the engineer — responsibility to himself and to his company . . . . says President Rockwell

What does Management Expect of the Engineer?

"ARE you kidding?" If a newly graduated engineer were asked what he thought management expects of the engineer, chances are that rhetorical question would be his answer. In view of today's bizarre "head hunting" practices, on and off campus, such an attitude is not surprising.

About the only responsibility an engineer has, to judge from the "world is your oyster" employment ads in the newspapers, trade, and technical magazines, is to "join the team at . . ." Once on the team, the engineer spends his time thinking about the space-time continuum, while his family is at the swimming pool or at the cottage-by-the-sea. Meanwhile, the company is quietly accumulating a pension fund so that the engineer won't be disturbed by petty monetary worries. If they don't come right out and say so, this is the situation current engineering employment ads broadly imply!

As an engineering-minded company, we place a high value on the skill and ability of engineers. Through engineering we have grown from a one-plant, one-product company to a 20-plant company making basic products covering 25,000 models — and through good engineering we are continuing to grow. But we do not think we would attract the type of engineering talent that has made the company successful by participating in the "you want it we got it" talent hunt.

An engineer deserves to be treated with dignity and respect as a human being of high order — not as a commodity to be traded over (and under) the counter, or stockpiled for future use. Management has the responsibility to provide the engineer with ". . . opportunity to advance, to produce, and to participate to the extent of his abilities and on an equal footing with others in the organization . . ."

But the engineer also has a responsibility to management which he must discharge if he expects his career with a specific company to be successful. And management would be remiss if it did not demand high standards of performance from the engineer — just as the engineer would be remiss in not demanding that management fulfill its responsibilities. This is not as quixotic as it may sound. If the "demands" are not made and met, either the engineer will be discouraged or he will not do the best he is capable of doing. The company stands to lose regardless — an unhappy, discouraged engineer is a bad investment; and a poorly performing engineer is a bad investment.

Initial Responsibility

Special situations aside, an engineer seeks to work for a company where he can make a successful, life-long career. Management, on its part, wants to hire engineers on the same basis, for only with such a relationship can an engineer substantially contribute to the company's growth and development. When an engineer accepts a position, management should be able to assume that first, the engineer has carefully considered all of the factors entering a job decision; and second, that barring the unexpected, he is ready to make his career with this company.

From the engineer's point of view, job hopping is a poor way to further a career. And from management's point of view, a job hopper represents a bad debt. Money, time, and effort spent in training and education are lost when an engineer takes off for other "pastures" where "blue sky" promises abound.

At Rockwell, we do not subject engineers to a "weeding out" process, or keep them in reserve in case of shortage. An engineer is hired for specific existing openings. Therefore, it is particularly important for us and companies such as ours to be able to assume that an engineer accepts a new position on a permanent basis; that he has fulfilled his initial responsibility to give the necessary thought and deliberation in seeking a position. In a brochure prepared for new graduates seeking employment we say: ". . . The success of your career and future depends on your decision. Be cautious. When you evaluate a company consider its history, stability, and reputation, markets and products. Do not base your decision solely upon a booklet or the personality of an interviewer. If possible, get a firsthand look at the organization. Talk to the engineers who work there. Analyze, compare, and judge the merits of the company. Then — make your decision . . ."

We have had cases of engineers who were lured away by some of the "pie-

TURN TO PAGE E-7

Representing Management

Willard F. Rockwell, Jr., a graduate engineer of Pennsylvania State College, has been a director of Rockwell Manufacturing Company, Pittsburgh, since 1940, and president since 1947. He became vice president and controller in 1939 and — after World War II service as a captain in the U. S. Army — returned in 1945 as vice president and general manager.

Among his many civic and industry responsibilities, Rockwell is president of the Pennsylvania State Chamber of Commerce and co-chairman of the Tax Advisory Commission appointed by Governor Leader (July, 1956) to work out a solution for the state's serious financial problems. He is a director and past president of Gas Appliance Manufacturers Association and a director of American Gas Association.

What Does Management Expect of the Engineer? . . . . . Continued

vice president. If the engineer aspires to a position of top rank and corresponding pay, he must move over into management or he must seek elsewhere for a career.

It is essential that the engineer realize that management is a separate and distinct profession requiring special skills and abilities. The engineer is not educated in these skills nor does he learn them in performing engineering work. They must be acquired by means of special study and experience gained through the practice of management.

Management should recognize this and share management responsibilities with engineering personnel. Only in this way can the engineer acquire a "feel" for management. The engineer may discover that he has no taste or talent for management duties. If he does he will be far more content to remain in engineering. On the other hand he may prove quite adept at managerial skills and find the work to his liking. If this is discovered and there are no blockades placed in his path by a narrow-minded and jealous management, he will surely find his place in the sun.

A pet peeve of engineers, especially at lower levels, is that they are used as clerks or office boys and have little opportunity to produce as engineers. This complaint is not always justified but all too often it is. A great deal has been written about easing the shortage of engineers by more efficient utilization of specially trained personnel. The engineer has a right to expect opportunity to do engineering work. He should think twice, however, before he complains at being asked to make an economic analysis of a project or to check the accuracy of a proposed financing plan. Possibly without his knowledge he is being given a taste of management training.

Another opportunity to which the engineer feels entitled is the opportunity to participate. Of course we all want to share in the profits of our employer. In order to be eligible to share in the profits, we must also share the problems and difficulties. When a deadline is confronting management, the engineer appreciates knowing why he is expected to give up a few evenings at home and a long planned week end. When he knows, he will usually carry his share of the load willingly.

Recognition

Nothing will stifle a man's willingness to help out in a pinch like failure to recognize his extra effort. If the emergency involves a bit of routine work which is behind schedule and must be brought up to date, a pat on the back will suffice. If the added work is occasioned by some extra business which will benefit the company, then some more substantial recognition in addition to the pat on the back is in order. This extra recognition can take the form of a raise in salary or a bonus — but the pat on the back is still a must.

Respect

The engineer expects respect from his employer. As a professional man he expects to be treated as such. I know a prominent architect-engineer who lost a valuable assistant because he insisted, when time clocks were installed, that every one must have a time card and punch the time clock. The employer made it perfectly clear that the upper level men in his organization would not in any way be affected by the time clock or by the hours shown on their time cards. The employer himself agreed to have a time card and to punch the clock faithfully.

This explanation was to no avail. His chief mechanical engineer would have no part of the scheme and forthwith quit. The employer was not successful in coaxing him back. In fact the disgruntled engineer was highly successful in setting up his own firm in direct competition with his former employer.

Once I informed my immediate superior, the chief engineer, of my intention to resign to accept what I believed to be a better position. I had informed my new employer that I would be able to start work in 30 days or sooner if it was possible to turn over my duties and responsibilities to another.

The chief expressed his appreciation at being informed of my intentions but admonished me not to let "The Old Man" learn of my intention to resign. On previous occasions, when "The Old Man" learned of the intention of an employee to resign, he had informed the employee, regardless of his position or the nature and status of his work, that no notice was necessary or expected and to stop by the office for his check in 15 minutes.

This same employer habitually gave his employees 15-minute notice when they were being terminated for whatever reason. The effect of this attitude on the part of the employer, of course, reflected in the attitudes of his employees toward him. Whenever the work load begins to fall off to any degree, a great many of his employees begin to "shop around." My association with that company ended several years ago. I hear that the policies of "The Old Man" are unchanged.

Confidence

Confidence should be bestowed upon those who merit it. The engineer is no exception. When the work of the engineer has been proved sound; when he has shown himself to be a careful and able designer — his work should be accepted.

I would not abolish the time honored (and thank God, many times proved) practice of checking. Nor would I insist that the work of the engineer be checked only by another engineer. Those portions of the engineer's work which are strictly technical should not be subject to question by the accountant who is called upon to check the accuracy of the calculations.

Conclusion

In preparing this paper, I have thought of the engineer who is employed by an enterprise whose principal product or service is something other than engineering. Many such businesses, however, are largely dependent upon the work of their engineers. Oil companies are examples as are many manufacturing and construction companies.

Fortunate indeed is the engineer who is employed by a successful engineering company. There can be little doubt that it is possible for an engineer to rise to the top in such an organization. Also he will have ample opportunity to practice engineering. The attrition is great in such an organization, however, because the competition for advancement is from other engineers. It is possible to become lost in the multitude and few are able to keep their heads above the common level.

In such a company it is the responsibility of management to take great care lest the engineer with the glib tongue and the ready wit overshadow the more capable man. Management must be aware of the value of technical proficiency. It is equally important that the job be done correctly as it is that the contract be obtained in the first place.

The engineer who is technically proficient and consistently turns out sound engineering work should be as well compensated as his contemporary who does not bother with the details of the job but is successful at client relations. Both are vital and necessary to the successful conduct of business and only rarely are these qualities found in the same individual. ★ ★ ★

Whether you are in an engineering job or deal only with management problems, these two viewpoints are valuable to human relations. If you have still another view or a further argument on one side or the other, we'd like to have that, too.

---

in-the-sky" offers now prevalent. They found that the change did not permit them to make the solid progress on which both professional stature and a satisfying personal and family life can be built. We learned that because they told us so when they came back to work for us.

Responsibility to Develop

Management can only go so far in providing the engineer with the means to gain added knowledge and develop swills and abilities in his profession. The engineer must be willing to invest his time and effort to take advantage of the opportunties offered and to seek others. If he wants to be treated as a professional, he must act like a professional. And a profession cannot exist on a 9-to-5 basis.

An engineer should continue a certain amount of formal education. But even more important is his informal education — the learning and doing on his own. This includes keeping up with technical and trade magazines and other publications; active membership in important trade and technical societies and associations; preparation of papers and articles.

Equally important is a professional attitude toward his work. Management's evaluation of the engineer will reflect the engineer's evaluation of himself. If his attitude is that he just has a white collar job requiring his presence at a certain place for a stated interval of time, management can hardly be blamed for not according him the respect due the dignity of the professional.

Certainly there is much that is routine in his work — there is routine even in pure research. But the engineer should strive to seek for new answers, new approaches, new solutions to even small problems or routine situations. For only in this fashion will he be able to solve large problems or meet new situations.

The engineer should be curious and inquisitive about the work of his fellow engineers in the company. He may be able to learn something that will help his work or he may contribute to the progress of another's project. "Talking shop" after hours, in the relaxed atmosphere of easy discourse can result in highly productive ideas.

It all comes down to the matter of attitude. The engineer should take himself and his work seriously. If he is to be considered a professional rather than a skilled technician, the engineer must actively engage in his profession.

Responsibility to the "Whole"

All too frequently the engineer tends to restrict his thinking and interest to the purely engineering aspects of the company. But of necessity, he must deal with sales, marketing, cost accounting, public relations, and other departments and sections. Management people expect the engineer to work with them and their problems in the same straightforward way he deals with engineers and engineering problems. If people in the company "hate to talk to the Engineering Department" or if "Engineering" develops the reputation of "looking down its nose" at non-engineering matters, management and the company suffer — and the engineer suffers.

Operation of an industrial enterprise is complex — and getting more complex each year. It is getting harder and harder to draw lines of differentiation or responsibility between various skills, professions and departments. Where once the cry was for speciality, now versatility is being sought more and more. And versatility is what management seeks from the engineer. One of the important objectives of the engineer's education and training is clear, logical thinking. This makes him all the more valuable for the contributions he can make to the solution of problems in other phases of the company's operations.

Responsibility to Dissent

Ostensibly, the engineer bases his conclusions on objective facts rather than on the shakier foundation of subjective opinions. At any rate that is one of his objectives — and for that reason he is very valuable to management; because management, too, seeks objectivity in making decisions and drawing conclusions. Management assumes that the information obtained from the engineer can be considered in the class of "objective facts."

To properly serve management, the engineer must strive to retain his objectivity, even at the risk of being unpopular or disliked. For in the long run, he will be respected, which is far more important. More than others in a company, the engineer must be ready to dissent, if the facts as he knows them so dictate. It is not for him to ingratiate himself by readily agreeing. It may be that factors of which the engineer has no knowledge or of which he could not be aware, make it desirable to follow a different course. But the engineer should still stick to his evaluation as he knows the facts. Management can then be confident, when it asks for advice or opinions from Engineering, that it will get the best analysis the engineer can give, based upon his work and knowledge.

There was a cartoon in one of the mass circulation slick paper magazines which showed the founder of the XYZ Testing Laboratories in his office, talking to a visitor. Behind him on the wall hung a picture of a little shack with the company sign above the door. Through the office window could be seen a huge complex of buildings, with the "XYZ Testing Laboratories" sign on each building. The company head is saying to his visitor as he points to the picture of the shack: "We started out in a modest sort of way, making impartial tests for industry. Then, as time went on, we found that by making our tests a little less impartial . . ."

Management expects the engineer to remain "impartial."

Responsibility as Management

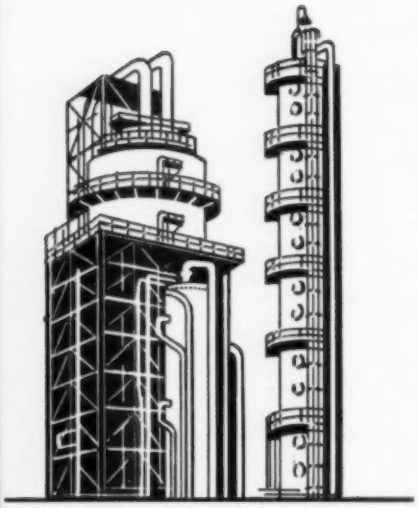
The shortage of engineers today is a reflection of the fact that the tempo of the technological revolution in industry is rapidly increasing. Even excluding the companies and industries that, by and large, serve the defense needs of the country, there is more engineering going into the production of goods and services than ever before.

Even further, the engineering approach is becoming more and more prevalent in sales strategy planning and broad marketing plans; operations research and systems planning are affecting accounting practices, materials handling, distribution, etc. This means that the engineer has more opportunities to rise rapidly in management.

First, a man should decide if he really wants to be in management — if he is equipped by personality and temperament for the type of job that requires "paper shuffling," supervising and directing people in diverse activities. If an engineer is happiest in engineering — he should recognize that fact. There is plenty of opportunity for progress, growth and development as an engineer. He will serve himself and management best by sticking to his last and developing engineering skills.

But if he is good management material, the engineer should make every effort to pick up the additional skills he will need in management. He must learn something about corporate finance, labor and industrial relations, and cost accounting. He should develop speaking and writing skills. He should take advantage of displaying his managerial capabilities whenever the chance is thrust upon him, i.e., as a project leader, or making a presentation on a problem to management.

In short, management expects the engineer — as a key member of a company's staff — to perform at his maximum capability. For in that way both the profitability of the enterprise and the success of his career will be maximized. ★ ★ ★



How Refiners

T. W. Warren

R. C. Kersten

IN the complex technology of modern petroleum refining, the efficient and economical production of high-octane gasoline presents a big problem. With today's prices and competition what they are, refiners must strive constantly to keep their costs as low as possible. This has become more and more difficult in recent years, for, as octane numbers rise, costs go up even more steeply. Presently, as a matter of fact, it costs four times as much to add an octane number at the 96 level as it does at the 84 level (Research).

As they attempt to produce gasolines of higher octane quality, many refiners are finding that moderately severe catalytic reforming no longer is sufficient. Aromatics extraction, second-pass reforming, alkylation, precise fractionation, and even isomerization — operations previously considered economical only under special circumstances and hardly ever associated with motor gasoline — are becoming necessary. In some cases, they are being used already; in others they are in capital budgets.

For all refiners, a careful economic analysis is needed to balance these processing alternatives to achieve maximum high-octane production at lowest possible cost. A clear understanding of octane-improvement methods, of course, is essential to such an economic analysis.

Any refining step carried out solely for the improvement of antiknock quality is defined as an "octane-improvement process." Thus thermal reforming, catalytic reforming, TEL addition, undercutting to distillates, desulfurization and isomerization are octane-improvement processes. Cracking processes carried out primarily to increase the value of heavier crude oil fractions by converting them to gasoline and distillates, do not fit the definition. Polymerization is seldom an octane-improvement process since the conversion of gaseous hydrocarbons into gasoline is an operation carried out to increase the field of a more profitable product.

Alkylation of isobutane and olefins may or may not be an octane-improvement process. When conducted for the purpose of obtaining blending stocks for aviation gasoline, it is not. If alkylation produces motor alkylate that would otherwise be unprofitable, it can be considered an improvement method.

TEL Addition

Determining the best possible use of the several octane improvement methods becomes more complex after lower-cost methods—reforming virgin naphtha and the addition of tetraethyl lead—have been used to the fullest extent. In this connection, the trend in gasoline to higher concentrations of aromatics and the increasing size of octane numbers in the higher ranges are reducing TEL response in terms of octane numbers.

This raises the question of what TEL costs will be in 1958, when the industry is expected to have installed the optimum amount of catalytic reforming equipment. Naturally, such costs will be determined in part at least by the extent to which any given refiner can use additional TEL up to the 3.0 ml per gal maximum. Within this limit, it appears now that the cost of severe reforming may be up to two and one-half times that of TEL, even though the costs are comparable under mild reforming conditions.

Another interesting facet of the use of TEL as an octane-improvement method is found in a comparison of research and road ratings. Research octane numbers usually are the standard used in evaluating new refining methods. However, data obtained from Ethyl Corporation's road evaluation program suggests that octane improvements measured on the road may be somewhat different from those determined through the laboratory Research method.

Certain process-TEL combinations, it has been found, may have important

Reprinted from the May-June, 1956, *Ethyl News*.

The Authors

T. W. Warren is director of refinery technology at Ethyl Corporation's Research Laboratories in Detroit.

Mr. Warren was born in Electra, Texas, and was graduated from the University of Texas in 1944 with a BS degree in chemical engineering. From 1944 to 1946 he served as a naval officer with the Seventh Fleet in the South Pacific. Upon his release from active duty, he joined the technical service division at the Baytown, Texas, refinery of Humble Oil and Refining Company. With the exception of 17 months' leave of absence which he spent as an aviation fuels specialist with the Petroleum Administration for Defense in Washington, Mr. Warren was with Humble until joining Ethyl Corporation in 1953.

R. C. Kersten is a project engineer in the refinery technology division at Ethyl laboratories in Detroit.

Mr. Kersten was born in Detroit and was graduated from Michigan College of Mining and Technology with a BS degree in chemical engineering in 1942. Before serving in the Navy as the commanding officer of a minesweeper in the South Pacific from 1944 to 1946, he was employed as an engineer by Chrysler Corporation. After the war, Mr. Kersten was a process engineer with General Petroleum and Socony Mobil Oil Company, before joining Ethyl in 1954.

Make Hi-Octane Gasoline

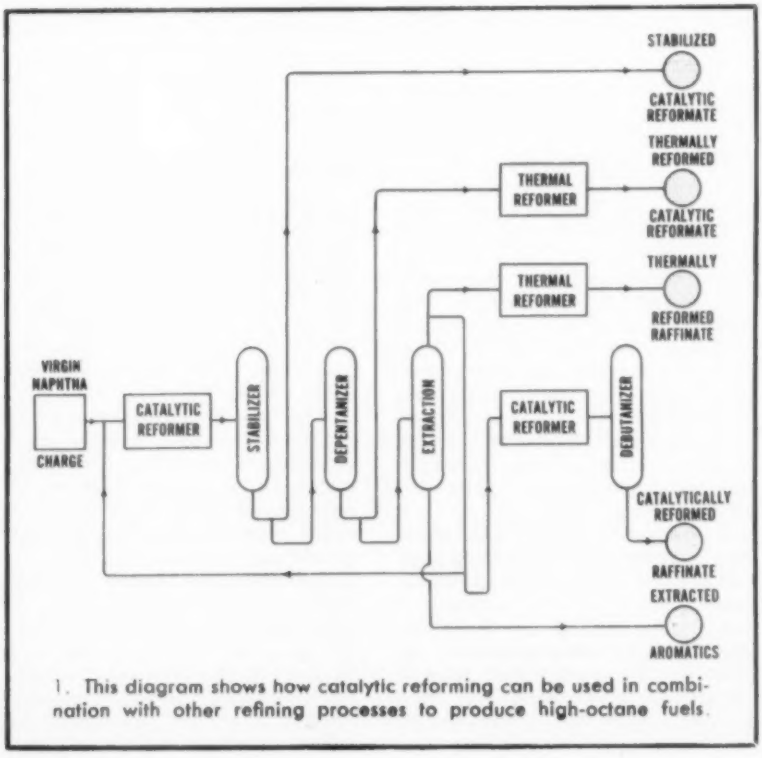
Refiners need careful economic analysis to balance processing alternatives to achieve quality production at low cost . . .
Here is a quick run-down on modern processes and their special values that will interest everyone in petroleum management

advantages not evident in the laboratory. Since such advantages could well affect a refiner's octane-improvement planning, Ethyl's work in the field of fuel behavior is currently designed to explore both the laboratory and road effects to the fullest extent.

Catalytic Reforming

The refiner who has either catalytic or thermal reforming equipment can gain octane numbers in several ways, depending on the flexibility of his operations. He may increase the charge rate — either by widening the boiling range of the charge or by fractionating more charge of the same boiling range from additional crudes.

Another possibility with this same equipment is to go to more severe operating conditions, either by increasing operating temperatures or by lowering space rates, thus obtaining higher octane numbers at the expense of yield. The incremental octane-improvement cost for a processing change in a specific refinery will be determined by many variables, not the least of which is the price structure under which the refinery operates.



1. This diagram shows how catalytic reforming can be used in combination with other refining processes to produce high-octane fuels.

Combination Processes

In addition to installing a catalytic reforming unit, or operating an existing unit under more severe conditions, there are several combinations of processes that will increase octane quality.

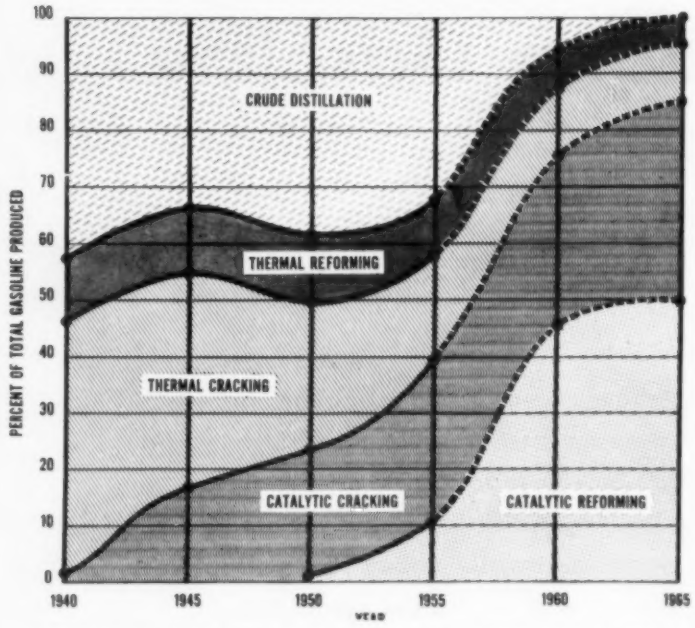
In this connection, three possibilities are currently being discussed widely in the industry. In the first, an aromatic concentrate is extracted from the catalytic reformate, and a second reformer is installed to upgrade the low-octane, non-aromatic portion of the reformate.

The second possibility requires extraction of the catalytic reformate. But rather than install a second reformer, the refiner recycles the non-aromatic portion to the original reformer, enlarging it to handle the recycle.

In the third method, the catalytic reformate from the base operation is thermally reformed, and a catalytic polymerization unit is installed to use the light olefins from thermal reforming.

Polymerization and Alkylation

Heretofore, processes such as polymerization and alkylation usually have not been considered octane-improvement processes. Instead, they have been installed to make a more valuable product out of a less valuable one. Thus, they usually have not depended solely on octane effects for profits. It is possible, however, to use these processes strictly for octane improvement.



2. This chart presents trends in the use of various processes for making gasoline. By 1965 catalytic reforming may be used to manufacture as much as 50 per cent of all gasoline.

Economic studies show rather clearly that the alternate-use value of charge stock to polymerization and alkylation is a controlling factor in octane-improvement costs. High feed-stock prices can easily cause costs to soar, particularly use as motor fuel components or equivalent value elsewhere.

Isomerization

An octane-improvement process known for some time, but one which has found only specialized application is the isomerization of pentane and hexane fractions. In this process, some butanes and hexanes are formed from the normal pentane charge along with the high-octane isopentane product. Again, since the vapor pressure of the desired product is greater than that of the charge stock withdrawn from the gasoline, the net butane usage must be reduced. The vapor pressure effect, the unit operating cost and capital investment must be carefully considered in evaluating this octane improvement method.

Octane Economics and Other Factors

In addition to octane number, gasolines, of course, have other specifications, such as volatility, which affect octane economics.

Engine warm-up characteristics of a gasoline are related to its 50 per cent evaporated temperature during the ASTM distillation test. When a refiner finds it necessary to go to severe reforming or to one of the reforming-extraction combinations to produce a high quality blending component for premium gasoline, he will find in many cases that the blending agent produced has a high 50 per cent point. Warm-up characteristics of his premium gasoline may suffer, therefore, unless he uses some operation, not defined by straight octane economics.

For example, in order to put enough light materials in the finished premium gasoline to obtain a desirable 50 per cent point, the refiner may have to reform more severely than would otherwise be necessary. Also, holding premium warm-up characteristics constant in the face of increasing octane number may require light alkylate or isomerized light naphthas before they would otherwise be justified.

A volatility problem concerning the heavy fractions in premium grade gasoline also may affect octane economics. Some companies market gasolines of low 90 per cent points in the belief that excessive high-boiling components increase combustion chamber deposits, reduce engine cleanliness and dilute crankcase oil. Other companies make full use of the heavy components because they give the consumer more pounds per gallon and because the heavy aromatics are high in octane quality.

Overall refinery economics seem to dictate that the gasoline boiling range be as wide as possible. Thus, the high-octane aromatics produced by catalytic reforming of naphthas boiling upwards of 200F may complicate the blending of premium gasoline. A refiner blending against a fixed 90 per cent point on premium may find that other processes, perhaps not otherwise called for, will be required for improvement of premium octane.

Because hydrocracking occurs to some extent in catalytic reforming, the relative quality of light ends (butanes, pentanes, hexanes) in a refiner's gasoline increases as octane number is improved. The quality of these materials (unless isomerized) is so low as to permit inclusion of only the minimum quantity in premium grades. Thus, the increase in volatility caused by severe reforming may be reflected only in regular grades and regular grades may give poorer protection against vapor lock. Vapor lock specifications of regular grade are, therefore, critical points that must be watched by refiners projecting octane-improvement plans.

Another problem, quite different from volatility, sometimes occurs when a refiner obtains the required number of octane barrels for his overall gasoline improvement program but lacks sufficient volume of high-octane material for blending his premium grade Here, the refiner may have to reform more severely or extract and recycle to an extent greater than would otherwise be necessary.

Precise Fractionation

These conflicts are expected to put more emphasis on certain refining techniques not generally associated with octane improvement. Precise fractionation will have to play a larger role in octane plans. More segregation of narrow fractions will require more tankage, another factor not generally associated with the octane problem.

With so many conditions involved, the problem of keeping a single product, gasoline, technologically up to date is indeed a complex one. However, the same conditions that make it complex create more opportunities for competitive advantages.

Cost differences among alternative improvement methods are now and will continue to be measured in cents per barrel, not fractions of a cent as in the past. Maintaining competitive position on refining costs will demand increasing attention to octane economics and to road performance. ★ ★ ★

BETTER ANSWER THESE QUESTIONS BEFORE VENTURING ABROAD:

1. *Is the government stable?*
2. *Are U. S. citizens welcome?*
3. *What terms and conditions can be made?*
4. *What corporate organization is best?*
5. *How can you stay clear of anti-trust violations?*
6. *What can you deduct for income tax purposes?*
7. *What is the "Calvo Clause"?*
8. *How do you get out capital and profits?*

Going Into Foreign Operations?

Burney Braly

ONCE it is decided, on the basis of geological information, that it might be profitable to own and operate a concession in a particular foreign country, questions as to the stability of the government and whether it could be depended upon to keep its promises are among the first that should be considered by a prospective concessionaire.

In our time we have seen revolutionary changes in governments in many parts of the world. They occur with amazing frequency and often unexpectedly.

Colonial peoples are on the march. New states are being born. Old governments in many parts of the world appear to be yielding to pressure from political parties which openly espouse State Socialism and even Communism.

But in countries which have successfully resisted such leftist influences, succeeding governments appear to have kept the promises of their predecessor regimes, at least as scrupulously as they have kept their own. I am told that this is a point of honor in most Central and South American countries.

Whether a foreign country may be expected to honor its obligations regardless of changes in the government depends largely upon the legal, social and religious culture of its inhabitants.

You well remember Mexico's expropriation of oil properties of American and English companies pursuant to an Executive Decree issued March 13, 1938. It is worthy of note that sparking that incident was a Communist labor leader.

Mexico's right to expropriate was conceded by our own Chief Executive and State Department, upon the condition that the Mexican government promptly, adequately and effectively compensate the owners for their properties. But oil properties come high and Mexico could not raise the cash. After long diplomatic wrangling and, presumably, to save the peace and prevent Mexico from rejecting a rule of international law, The United States advanced the money. Mexico never got its hands on the funds. When and as settlements recommended by a Joint Valuation Commission were accepted, our own State Department wrote the checks to the oil companies. This was more than five years after the expropriation decree.

The compensation supposedly represented the value of personal property and improvements — and no more. Significantly, Mexico prevailed in its contention that the settlements should not take into account the value of oil in the ground, money expended in finding and developing oil fields, or the value of the concession rights.

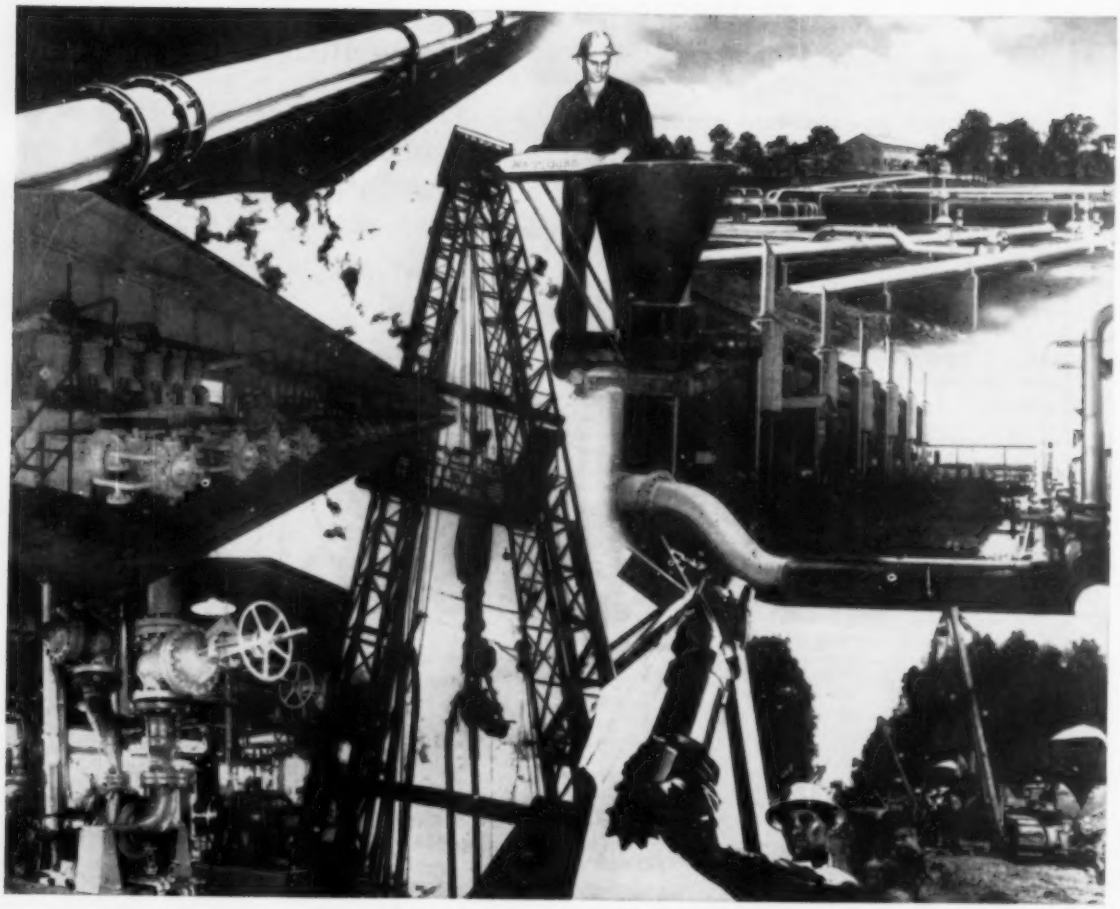
Still fresh in our memory is the upheaval in Iran following the expulsion of the Anglo-Iranian Oil Company pursuant to the Mossadegh regime's nationalization law. "Nationalization" under such circumstances is only a polite name for expropriation.

In the end, the Anglo-Iranian Company was permitted to return. In association with a number of other companies, it agreed to resume operation of the properties and pay over to the government 50 per cent of the net profits. The nationalization of petroleum remains in effect. The contracting companies have only operating rights, as distinguished from title. This, however, would not seem to be material if the Iranian government lives up to the new agreement.

After the expropriation in Mexico, the governments of certain other important oil-producing countries, by threatening nationalization of petroleum, forced the oil companies to agree to 50-50 profit-sharing. Provisions for like profit-sharing now appear in a number of petroleum codes. Specific statutory and contract requirements to that effect vary as between countries, but the pattern has been set.

History is warning enough that you should satisfy yourself as to the political stability of a foreign country and

Mr. Braly is associate general counsel, Continental Oil Company. This article is a revision by the author of a paper, "Problems Relating to Negotiations of Foreign Oil Concessions," given before the 1956 annual meeting of AIME in New York.



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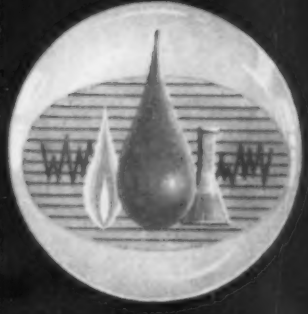

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whether it can be reasonably expected to adhere to its agreements, before you venture into that country in search of oil.

Eligibility of Applicants

When an American citizen goes into a foreign country for any purpose, he immediately becomes an "alien," or "foreigner." Therefore, I would rank next in order of importance in our study of problems, the question of whether an American citizen would be eligible and welcome to operate in the country under consideration. And, even if that question is answered affirmatively, could he expect to receive the same kind of treatment as that accorded the natives and nationals of other countries?

The mining laws of a country may expressly deny aliens any right to own concessions or grant them such rights only upon conditions of reciprocity. This is not unfair.

You may find that some countries considered "friendly" pay only lip service to the "open door" policy. Or you may encounter gross discrimination in favor of local citizens or nationals of some other country. Do not be surprised if you find this to be true in colonial territories as well as in independent states. The mother country may wield a monopolistic influence favoring its own citizens.

Most of us are averse to government-in-business. But since our domestic abode is not altogether clean in this respect, our right to criticize other governments for participating in foreign oil operations may be questionable.

In light of the basic concept of national sovereignty, it would seem to be anomalous for one nation to own, directly or indirectly, interests in oil and gas deposits within the domain of another nation. Mindful of the full import of sovereign rights and powers, some countries, in enacting their petroleum laws, have declared foreign governments and persons, institutions or organizations that belong to or depend directly or indirectly upon them, ineligible to hold concessions.

Ownership of Deposits

A valid petroleum concession can be acquired only from the person or corporation or the government (state or lesser political subdivision) that owns the petroleum in the land. In the United States and a few other countries, the mineral resources are variously owned, some by the central governments, some by the states or provinces, and some by persons and corporations.

The owner, whether public or private, may or may not hold title to the surface estate. Most foreign governments assert title to all petroleum deposits within their boundaries, and the attendant right to grant concessions.

Evidence of a nation's title to the minerals in alienated land within its boundaries may be found in its constitution or statutes. In the absence of constitutional or statutory provisions on the point, you will have to rely on an historical or traditional assertion of government ownership of the mineral resources. Since there is no universal rule it should be referred to reliable counsel in the country of interest to you.

Terms and Conditions of Concession Agreements

1. Limitations on Areas and Number of Concessions. Petroleum codes usually restrict the number of concessions as well as the area of each that may be granted to a single applicant. Where there is no statute on the subject, the size of the concession area is generally settled by bargaining with the government.

Egypt's code limits the areas of concessions in a certain part of the country but empowers the ministry in charge of petroleum resources to grant concessions in the western desert, without limit as to size of the area included and on such terms as the ministry might deem appropriate. There may be other countries where such limitations do not apply uniformly to all districts or provinces.

Because of the tremendous cost of geological and geophysical surveys and exploratory drilling, as well as the probability of having to carry out such surveys over hundreds of square miles of territory before finding indications of oil, experts tell us that exploratory concessions should cover expansive areas. In areas where the geology is well known or where commercial production has been established, smaller selected areas may be acceptable for exploration as well as exploitation.

Recognizing the risks inherent in the search for petroleum, some petroleum codes authorize concessions that provide for two or three operational steps or stages, under differing acreage limitations. In the first stage, the concessionaire may have the right to conduct only surface reconnaissance over a large or even unlimited area; in the second, to carry on geophysical operations and drill test holes in a selected limited area; and in the third, to drill wells and produce in a still more limited area. In some cases, the first two stages are telescoped into one. In others, the last two are combined.

These different rights may be provided for in separate successive contracts: (1) an exploration license, (2) a prospecting license, and (3) a lease or final concession. Nomenclature is unimportant. The term "concession" is merely generic. The contracts may all be called "rights," "permits," "leases," "licenses" or "concessions," preceded by appropriate words distinguishing each stage from the others.

Where the concession is negotiated, the privileges of exploring, prospecting, and exploiting may be covered by a single concession contract, thus obviating any necessity for future negotiations and additional contracts as the project progresses from stage to stage.

2. Defining Concession Area. Concession contracts, like deeds or other grants of land, should clearly describe the land intended to be covered. This is particularly important when operations reach the exploitation stage. Boundary disputes in highly developed oil fields in this country, notably in Texas, have resulted in staggering losses to some operators and corresponding windfalls to neighboring operators and royalty owners and the government. I have heard of a similar instance in a highly developed field in South America where the government contended that certain productive wells drilled by a concessionaire were on land not within the confines of the concession, and hence belonged to the government.

In many foreign countries, the deserts and swamps have never been accurately surveyed or monumented. There the concession may require the operator, within a limited time, to survey and establish corners and lines of the area meant to be included, and obtain government approval of the work. Even in the absence of such a provision, the concessionaire, for his own protection, should accurately locate and monument his concession area before drilling wells in the vicinity of what he supposes to be his boundaries.

3. Purposes of Concession. A concession agreement should clearly state the purposes of the grant, leaving no room for interpretation. In addition to the right to explore and prospect for and produce petroleum, he should have the right to sell in the field or at any other point of delivery and to transport within the country and export through or by any facilities provided or selected by him.

If refining or manufacturing rights are contemplated they should be provided for in the agreement. In some countries refining and transportation rights are not included in exploration and exploitation concessions but may be obtained under concessions limited to refining or transportation or both.

4. Cash Considerations, Rents, Work and Expenditure Obligations. As you would expect, the original cash out-

lay for a concession, the annual rents and obligations to perform specific work or spend minimum amounts of money within limited periods, will vary widely among countries. In any country where the law does not require competitive bidding, the amount of such obligations will depend upon the type of the concession, whether for exploration or exploitation, and the size of the area covered by it.

Where a concession must be let to the highest bidder, the size of the area will not control the cost. Your competitors may force you to offer more than you would like to pay, if you are determined to be the successful bidder.

5. Government Royalties. The government's share of the production may also be determined by competitive bidding. This is not unusual in our own country. In foreign countries statutory royalties, may vary upwards from 12½ per cent. As already pointed out, 50-50 profit-sharing statutory and contract provisions are not uncommon.

6. Term of the Grant. In The United States, petroleum leases on public and private lands usually endure "so long as oil or gas is produced." With possibly few exceptions, foreign concessions run for fixed terms, that is, 40 or 50 years, with the right to renew for one or more shorter periods. This is not desirable but the practice appears to be firmly established.

Many oil fields under modern methods of production and conservation may produce for generations. It discourages what we in this country consider "good oil field practices" to put specific time limits on the right of enjoyment. An operator facing such a limitation may be expected, in his own interest and regardless of the public interest, to get out **all** the oil he can **while** he can.

Orderly development may extend over many years and entail the expenditure of enormous sums. If the concession runs for a limited number of years, a rich field may be discovered too late in the life of the concession for the owner to reap the full harvest of his sowing or even recover his investment. Time runs out. He relinquishes to the government. The government cashes in, either by carrying on operations itself or granting a new concession to the same or another concessionaire for a consideration measured by the then tremendous value of the developed field or fields. Shocking as this may be to our sense of fair play, no one stops to commiserate a concessionaire because of eventualities 50 years in the future.

7. Relinquishment and Assignment. The right of voluntary relinquishment should be stipulated in the concession agreement or provided for in applicable law which is read into the agreement. The concessionaire may be saddled with work and monetary obligations which successively increase from year to year, so long as he retains the concession. Therefore, he should be privileged to quit whenever it becomes apparent to him that the project is not likely to be profitable.

Also, the right to assign the concession in whole or in part is highly desirable. Generally such privileges are freely given and freely exercised in this country. Yet in most foreign jurisdictions, the right to assign is granted only upon condition of approval by the government. This is not surprising. It avoids speculation in concessions and prevents persons and corporations that are **persona non grata,** or otherwise ineligible, from acquiring concessions by assignment which they could not have obtained directly from the government.

8. Taxes and Duties Exemptions. Exoneration from taxes and export duties may be provided by the laws of a country in order to invite capital and encourage new industries. Where all concession terms are open to negotiation, relief from taxes and duties sometimes may be had for the asking. The possibility should not be overlooked. You may succeed, however, only in having tax and duty payments applied against the total obligation to the government under a 50-50 net profit-sharing agreement, or deducted in computing the net profits to be shared with the government.

Foreign income and excess profits taxes and taxes in lieu thereof may be (at the election of the U. S. taxpayer) either deducted from income or taken as a credit against income tax. Therefore, it would not be to the concessionaire's advantage to secure an exemption from foreign income and profits taxes which are a component of his total money obligation under a foreign concession.

It has been questioned whether exemptions from import duties are worthwhile to the concessionaire, in view of the task of keeping accurate records of imports and settling claims for duties on articles imported which are subsequently disposed of under circumstances making them dutiable. On the other hand, export duties on petroleum and petroleum products should be avoided wherever possible.

9. Depletion Allowances. Petroleum codes enacted in several foreign countries provide for depletion allowances on oil and gas production in computing income taxes.

10. Other Provisions. Concessions may appropriately cover the following, among other subjects:

(1) Obligation of concessionaire to supply some proportion of local demand before exporting oil.

(2) Inspection and supervisory powers of government agencies and reports to be furnished.

(3) Use of fuel, wood, sand, gravel and water for operations.

(4) Operating methods and practices.

(5) Employment of native workmen and contributions to education and training of employees.

(6) Protection and disposition of antiquities discovered.

(7) Payment of damages to occupants of land.

(8) Requisition of properties by government in emergencies and return thereof to owner at end of an emergency.

(9) Right to remove property during term and at end of the concession.

(10) Suspension of operations during intervention of Force Majeure.

Guaranteeing Performance

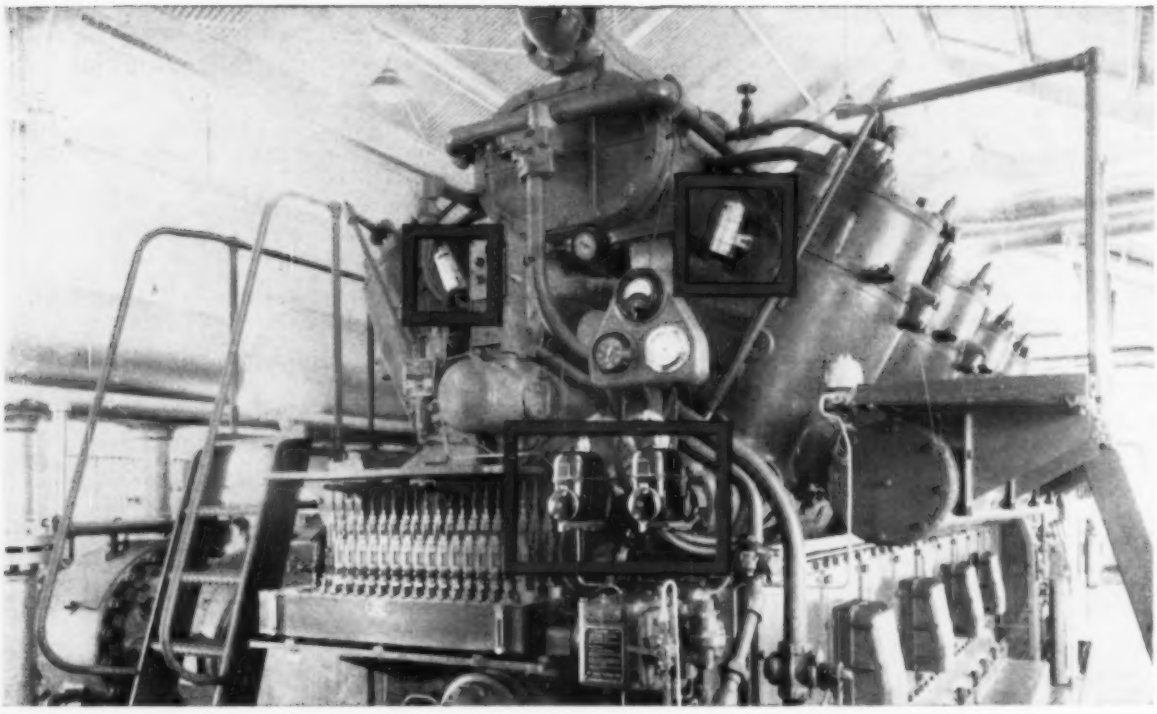
A bond or "banker's guaranty" is usually required as a guarantee of performance under any foreign concession. The amount, if not fixed by law, will be subject to negotiation. The surety or guarantor may be expected to require an indemnification agreement from the concessionaire, supported by a deposit of cash or other security.

If the guaranty must be executed by a bank or other institution domiciled in the foreign country, the guarantor may demand that it, in turn, be assured against loss by a bank in The United States, unless the concessionaire deposits with the guarantor a sum of money (ear-marked and interest free) equal to the amount of the bond.

In order to avoid risks entailed in maintaining a large deposit of cash in a foreign bank, as well as the resulting sterilization of that much of his capital, the concessionaire may find it to his advantage to arrange with a bank in this country to give the foreign bank the necessary assurance. That may be done by means of a letter of credit, to be drawn upon as and when demands are made upon the foreign bank under the performance bond. If the concessionaire is financially strong, the letter of credit may be obtainable without purchasing it or ear-marking a deposit of cash in the bank issuing the letter.

If a corporate concessionaire is financially strong, a foreign bank may be willing to execute the performance bond on the strength of an indemnity agreement executed by the concessionaire alone. If the concessionaire is a subsidiary corporation with limited capital, the bank would require both the parent and the subsidiary to execute indemnity agreements.

Care should be taken in drafting a performance bond to include provi-



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sions for sufficient notice of claims asserted thereunder to afford the concessionaire a fair opportunity to question or pay such claims before the government resorts to the bond. This caution is indicated by experience in one country where the statute requiring the bond did not specify its terms other than the amount. Only after extended negotiations were the parties able to draft a form that was acceptable both to concessionaires and the government.

Corporate Organization

Avoid Unlimited Liability Abroad. The greater part, by far, of business done by Americans in foreign countries is carried on through corporate instrumentalities. We form corporations to avoid personal liability of investors. For the same reason, big corporations form smaller ones. There may be other reasons, but this one is particularly important in foreign operations.

In order to minimize taxes and simplify control, it would seem advisable for a corporation, when expanding into new areas, either domestic or foreign, to carry on without resorting to the use of subsidiary corporations. But those advantages may not be enough to counterbalance the dangers inherent in unlimited liability that would attend a large American corporation upon domiciling itself in a foreign country.

The large corporation can avoid the possibility of ruinous judgments against it in the courts of a foreign country by operating through a subsidiary licensed to transact business there and having no more capital than required to enable it to be so licensed. Working capital in the form of loans can be advanced as the needs arise.

The subsidiary corporation expedient, however, may be unnecessary in some countries. For instance, Italian lawyers advised that a foreign corporation may establish a "branch" in Italy and, by appropriate stipulation in the registering papers, limit its liability to funds and other assets having a situs in that country. It may be that some other countries offer similar inducements to foreign capital.

Generally, where a subsidiary corporation is deemed necessary, it would appear to be preferable to have a domestic subsidiary acquired and operate the foreign concession. But in some countries it may be found that alien corporations are not eligible to hold concessions. Then the subsidiary will have to be created in the country issuing the concession or in a country related by political ties. Thus in British-controlled areas, a company incorporated anywhere in "Her Majesty's Dominions" would not be considered a foreign corporation.

The foreign law may go further and require that local citizens be afforded the opportunity to participate in the ownership and management of the corporation.

Antitrust Problems at Home. Not all problems arising in connection with foreign operations are due to foreign laws. The reach of our own antitrust and monopoly laws must not be overlooked. They have been construed to extend the jurisdiction of the U. S. courts and other enforcement agencies to activities which, though carried on abroad, operate to restrain the domestic or foreign commerce of this country. A corporation organized or domiciled in The United States is always within the reach of our courts.

Unfortunately, American business men find it relatively impossible to do business in some foreign countries otherwise than according to methods which, though perfectly legal and respectable there, may not be considered cricket in this country. In conducting their business in foreign countries, citizens of this country may incur serious risks if they rely implicitly upon the admonition, "When in Rome, do as the Romans do." Our Justice Department is perverse enough to regard this aphorism as not altogether valid. It says, in effect: "If you cannot do business in Rome except as the Romans do, then you'd better do no business in Rome."

Anyone obtaining a foreign oil concession naturally hopes that it will be productive — that he will in the future have oil to sell in the world market. If his hope is realized he eventually may encounter marketing problems under our anti-trust laws.

Statements in a few opinions of the judges in antitrust cases have raised the question in the minds of some lawyers as to whether a corporation may safely undertake producing or manufacturing operations abroad through subsidiaries or affiliated corporations. This and other antitrust problems in foreign trade have been interestingly reviewed in the 1955 report of the Subcommittee of the American Bar Association Committee on Antitrust Problems in International Trade. One conclusion of the Subcommittee reads as follows:

"With regard to foreign subsidiaries wholly owned by a single U. S. company, it is usually taken for granted that no antitrust violation arises merely from the creation of a new subsidiary or from the normal operation of the parent and subsidiary as a single concern.

"... It has already been squarely held that a single American company is free to create new subsidiaries abroad, in the sense that the decrees in foreign commerce cases requiring divestiture of joint interests regularly permit either owner to buy out the interest of the other, e.g., *United States v. Imperial Chemical Industries*, 105 F. Supp. 215, 242 (S.D.N.Y. 1952). The same reasoning would clearly apply to a subsidiary in which the U. S. parent owns a majority interest and the minority interests are owned by ordinary investors or other firms engaged in different and noncompeting businesses."

Because of the magnitude of the investment usually required to carry on foreign oil exploration and exploitation operations, even a large corporation may find it desirable to share its concession rights and operating costs with "partners." It is a fair implication from such case law as there is on the subject that it would not be illegal for two or more oil companies to operate a foreign concession through a jointly-owned subsidiary. I do not know of any opinion holding such corporate relationships to be illegal *per se*, but the decided cases involving joint operations are few. There would seem, however, to be no compelling business reason for jointly-owned subsidiaries in the field of petroleum operations, and in view of the uncrystallized state of the law, it may be advisable not to create or utilize them.

There is a safe alternative. Several corporate or individual owners may join in exploratory and producing operations on a foreign concession under an appropriate operating agreement without incurring liability under our antitrust laws. Or, they may safely group their severally-owned concessions and operate them as a unit. Such operations are common in this country and, so far as I know, in only one instance has their legality under the antitrust laws been questioned.

Any contract covering joint producing or processing operations either here or abroad should contain no agreement relating to the marketing of products which might in any wise restrict the domestic or foreign commerce of The United States.

Income Tax Problems. The parent corporation, in planning a foreign petroleum operation, should anticipate the possibility that the project may result in failure and consequently, insolvency and liquidation of the subsidiary. In any such event, it might be desirable for the parent corporation to be in a position to charge off, as an ordinary loss — instead of a capital loss — its investment in stock of the subsidiary, as well as advances to it. Of course, for sums to be charged off as advances, they must represent loans as distinguished from capital contributions; and the amount of any charge-off of an equity investment or advance will be limited to what in tax circles is called "adjusted basis."

For income tax purposes, stock of a domestic subsidiary corporation owned by the parent corporation will *not* be

treated as a capital asset if: (1) at least 95 per cent of each class of stock of the subsidiary is owned directly by the parent corporation (taxpayer); and (2) more than 90 per cent of the subsidiary's gross receipts for all taxable years has been from sources other than royalties, rents, dividends, interest, annuities or gains from sales or exchange of stocks and securities (I.R.C. 1954 Sec. 165(g) (3)).

Subject to a number of qualifying rules and regulations, the parent corporation can deduct, as bad debt losses, the amounts (adjusted basis) of advances to a subsidiary, either domestic or foreign, which become worthless, without regard to the percentage of the stock owned by the parent.

If the parent corporation owns at least 95 per cent of each class of stock, the conditions for inclusion of the subsidiary in a consolidated tax return will be more than met, insofar as stock ownership is a criterion of includability. For the subsidiary to be includable, only 80 per cent of the voting power and the same percentage of nonvoting stock need be owned by the parent corporation or other includable corporations (I.R.C. 1954 Sec. 1504).

By inclusion of the subsidiary in a consolidated tax return, the parent oil corporation may realize substantial benefits from: (1) the option to expense intangible costs incurred by the subsidiary in foreign petroleum operations, in the year in which such costs are incurred; and (2) depletion allowances on production from foreign concessions. There are no geographic limitations on these privileges of a U. S. taxpayer.

There is an exception to the exclusion of foreign subsidiaries from consolidated returns in the case of a domestic corporation owning or controlling, directly or indirectly, 100 per cent of the capital stock (exclusive of directors' qualifying shares) of a corporation organized under the laws of a contiguous foreign country (Canada or Mexico) and maintained solely for the purpose of complying with the laws of such country as to title and operation of property. Such a foreign corporation, at the option of the domestic corporation, may be included in a consolidated return (I.R.C. 1954 Sec. 1504(d)).

Summarizing: An established American corporation can avoid unlimited liability abroad by operating in a foreign country through a subsidiary corporation. In order to avoid possible antitrust problems, the subsidiary should not be owned jointly with other corporations engaged in the same line of business. To enable the parent corporation to maintain a favorable income tax position, the subsidiary should be a domestic corporation; the parent should own at least 95 per cent of the stock of the subsidiary; and the equity capital of the subsidiary should be minimal.

Abstain From Political Activities

Petroleum codes, other applicable laws, or the concession agreement itself may require a foreign concessionaire to sign a pledge that he will not engage in political activities in the country. Such provisions to that effect as I have seen make no attempt to define "political activities."

Concessionaires usually sign the pledge without questioning its implications, and with very good intention of living up to it. They hardly could be expected to restrain native employees from participating in elections and exercising other privileges of citizenship. However, there would be some risk involved in permitting natives of management rank in the concessionaire's organization to actively interest themselves in political matters.

Renouncing Diplomatic Recourse

An alien applicant for a concession may be required to sign an agreement to the effect that he submits himself wholly to the laws of the country and the jurisdiction of its courts insofar as his business here is concerned; that, with respect to such business he is entitled only to such rights, and manner of exercise thereof, as the laws provide for citizens of the country; and that he will not request his own government to intervene through diplomatic channels in any controversy he may have with the government granting the concession.

The signing of such an agreement is referred to as "renouncing diplomatic recourse." If the applicant is a corporation, a resolution of the board of directors to the effect stated may be made a condition to the granting of the concession.

Such a provision in the concession or in a collateral agreement is known as the "Calvo Clause." It derives its name from Carlos Calvo, an Argentine judge who was the author of an opinion to the effect that aliens should have no diplomatic recourse when dealing with his government.

Our own State Department has consistently taken the position that a citizen of The United States may not renounce the right of his government to intervene in his behalf in controversies between himself and a foreign government; although he is free to waive or renounce any private right he possesses. This position of our own government has been made plain to other governments. Nevertheless, a citizen of this country who has signed a Calvo Clause might, in good conscience, feel constrained to forego appeals to his own government and suffer in silence.

Repatriation of Capital and Profits

Most countries invite and encourage the importation of foreign capital for purposes of industrial development. From under-developed areas of the world come the more urgent invitations. Quite understandably, any government may be loathe to see imported capital return to its homeland or go to another country. Therefore, we may expect to find in foreign countries where Americans would likely go to search for oil, legal restrictions upon the repatriation of capital and profits earned thereon.

"Expatriation" would seem to be the proper word to denote withdrawals of profits on such operations. But "repatriation" is quite generally used when referring to withdrawals of either capital or profits. Laws and regulations on the subject usually specify the percentages of capital and earnings that may be repatriated in any one year. Percentages will vary among countries since each nation is free to adopt, enforce and alter its own rules on the subject.

If you should be fortunate enough to produce oil for export, other currency exchange regulations in the country of origin, as well as in countries where the oil is sold, may present problems. If this occurs, only someone trained in international banking would be able to give you the expert advice you will need.

After satisfying the country's requirements or some portion thereof, the concessionaire may be permitted to export petroleum and refined products to any other country and take payment for his products in any currency acceptable to him. However, in the country where the sales are completed, he may encounter difficulties in obtaining dollar currency or credits to bring home. Though he may not be required to return the proceeds of such sales to the country in which the products originated, he will have to account for such receipts against his repatriation allowances.

Unfortunately, there is always the possibility of emergencies in foreign countries which would hamper, if not prevent, the withdrawal of deposits. Also devaluations of national currencies by law or executive decrees are not uncommon. It would seem to be advisable, therefore, when you are engaged in a foreign operation, not to transfer to depositories within the country more funds than may be currently required for the enterprise. ★ ★ ★

Eleventh of a series

Communication:

"Do You Want Superior Reports?"

Dennis Murphy

DID you ever scratch around like a one-armed paper hanger with the hives to gather up facts, write a beautiful report, and send it to your boss — never to hear of it again?

You almost sweat blood while writing the darn thing, and, as you wait for weeks, you grow mad enough to quit! You would, too, if it weren't for your wife and kids. Why didn't your report get through and bring some kind of reaction? Probably unread, it's been filed away to gather dust. What's wrong?

Chances are: its timing was off, it got smothered by more urgent business, it covered information already found from another source, its problem has been resolved or changed, or it was too long and ponderous to plow through. Yet the receiver could at least have said, "Got your report, Jack, but haven't found time to study it!"

How Do You Report to Your Boss?

All executives, managers, supervisors, and first-line foremen rely on reporting. Study your boss to learn what kind of information he wants and needs; then try like the dickens to please him. Ask him outright how he prefers your reports. You have four ways to reach him:

1. **By telephone.** This is the quickest for a short oral report; but words and figures can be misunderstood, or forgotten if they're not recorded. Keep a penciled record of each call, and *be sure to date it*.

2. **By interview.** This excellent way to report allows you to show and explain with your voice, motions, facial expressions. You learn more about people this way, and the meeting of two minds is a test of quick-thinking — but it's so time-consuming that few top men can afford it. That's because some people can stay longer in five minutes than others can in an hour!

3. **By memorandum.** This is the quickest written report (excepting the informal note) and is recorded with at least two dated copies, but a memo can bog down in the routine delivery of the boss's mail. Mark it "Personal" or "Confidential," and you'll get results!

4. **By written report.** Let's examine this accepted way of communicating on complex, technical material. It's the most formal and complete, but the slowest because it requires study. Any number of copies can be made, and it's a permanent record.

What Is a Report?

A report is *not* a useless piece of "busy work" to justify an employee's existence, an exercise in written English to give the boss some practice in reading, or an excuse for another raise in salary. The written report is a powerful instrument for getting the job done, and the best report carries information "hot enough" to be of value *now*.

Dr. Murphy is administrative assistant, Service Pipe Line Company.

Report is a Communication

The word *report* means "to carry back." So report is an orderly account of some matter that's been investigated for the boss. This is done by research ("searching again"), experiment, inquiry, observation, study — any means of reaching right conclusions about the matter. With facts as evidence, it tries to treat its subject fairly and honestly.

Kinds of Reports

We have as *many kinds of reports* as we have bosses, workers, and jobs. As to subject matter, we may call them financial, engineering, geological, and the like. As to function, we may call them periodic (daily, weekly, monthly,) progress, analytical, critical, and the like. No matter what we call them, *they're all communications*.

And we have letter reports, memo reports, and long formal (sometimes bound) reports. We may think of most of them as going from employees *to* management; but stockholders, supervisors, employees, and customers also receive reports *from* management. They travel in all directions, up and down, over and across. But no matter how they move, *they're all communications*.

Parts of the Usual Report

Each report should fit its own subject matter, purpose, and audience. Any slavish conformity to an outline will end in a lot of balderdash and bury the main points; yet top managers will find it easier on them if all intracompany reports follow a uniform order, typography, and setup. Here's a flexible out-

line suggesting the relative importance of parts to the usual reader:

1. Cover	Secondary
2. Title page	Secondary
3. Table of contents	Optional
4. Letter of authorization, letter of transmittal, foreword or preface	Optional
5. General Summary	Most Important
6. Suggestions and recommendations	Very Important
7. Body — step-by-step discussion of subject	Very Important
8. Appendix — including charts, illustrations, photographs, diagrams, figures, graphs, maps, bibliography, etc.	Important or secondary or optional

The first four parts are relatively unimportant; the last four are highly important. Often a descriptive title for (2) will take care of (4). The table of contents is necessary for reports under five pages; for those over five pages, it can serve as an outline. Frequently (5) and (6) can be combined. And a company might profit by the use of uniform covers for all its reports.

Frankly, I wish we could reduce the number of formal written reports, shorten them by cutting out parts that cause repetition or backtracking, and make them all more readable, but we can streamline or simplify the ones we *have* to write.

Diving Into the Actual Work

Whether the boss assigns your subject or you originate it yourself, you surely have some general notion of its background from preliminary study. It's still a pretty good plan to write a brief statement of exactly what you're going to do — to clarify the problem in your own mind. You may need to

Reports Go in All Directions

use both *primary sources* (the thing itself) and *secondary sources* (what others say about the thing) in your research.

1. **Collecting.** Gathering data and information is slow, arduous work. Collect only facts, figures, and ideas that are reliable and representative, and record each item on a separate note card of, say, 3 x 5 in. Keep thinking about your total report and visualize it in finished form. This is important.

2. **Organizing.** Organize, sort, and tabulate all data according to major and minor parts or sections of your whole study. This is the time to make a working outline from the natural divisions that your note cards fall into. Keep turning the whole report over in your mind, and try to visualize it complete.

3. **Writing.** Using your outline, dash off as fast as you can a first rough draft. Don't pay too much attention to proper language and punctuation, jerky transitions between paragraphs, or sentence structure — just get it all down on paper. The object here is to capture the body of your report in one continuous piece! Try to write this rough draft in one day; if you take three days at it, your report may sound as if three different people wrote it!

4. **Revising.** To write is human; to revise is divine. Let your rough draft rest a few days to "get cold." Turn your attention to something entirely different. Finally, wade back into it, coldly and critically, and polish it up. This painstaking work pays off; so revise long to make your report short. Cut all needless words, straighten out tangled sentences, check for smooth sequence, and make each word say exactly what you want it to.

Some General Tips

Follow the order of a news report in your daily newspaper: the headlines; the summary in extrabold or boldface type; and then the body of the story in standard type. Don't follow the order of a mystery story, or the boss may never find out how it ends!

1. **Keep one specific reader in mind — the man who will get it.**
2. **Explain clearly and briefly to him what your report's about.**
3. **Proceed from the general to the specific. First give the frame; then, the full picture.**
4. **Don't bury important points under an avalanche of details.**
5. **Be consistent in spelling, abbreviations, graph scales, and so on.**
6. **Use plenty of headings, subheads, and underlining to highlight your main points.**

Give Your Summary First

This is the most important part of your report. Why should it be buried in the middle of page 17 at the end of your discussion of the subject? It's *not* the same as a conclusion to the body of your report; so don't confuse the two.

Your summary tells briefly what your report's about and what you found out. It devotes a sentence or two to each of these: the purpose; the background; the method used; steps in the study, experiment, or investigation; and the results. *It's everything in a nutshell.*

No matter how technical or scientific the body of your report is, and no matter whether your reader is an engineer, chemist, or accountant — your summary *must* be in words that can be quickly understood by top men who are *not* engineers, chemists, or accountants. Use language a layman can easily understand. This means words that are simple, clear, and accurate.

Put your summary as near the front (or top) as possible. Hold it to one page, if you can; half a page is even better. Why? Purpose of this summary is to save your boss time and trouble — sweat, blood, and tears — headaches and ulcers.

Offer sound suggestions and recommendations, whenever you can, as a part of your summary. Your boss wants practical *answers*, not wild guesses or dubious conjectures.

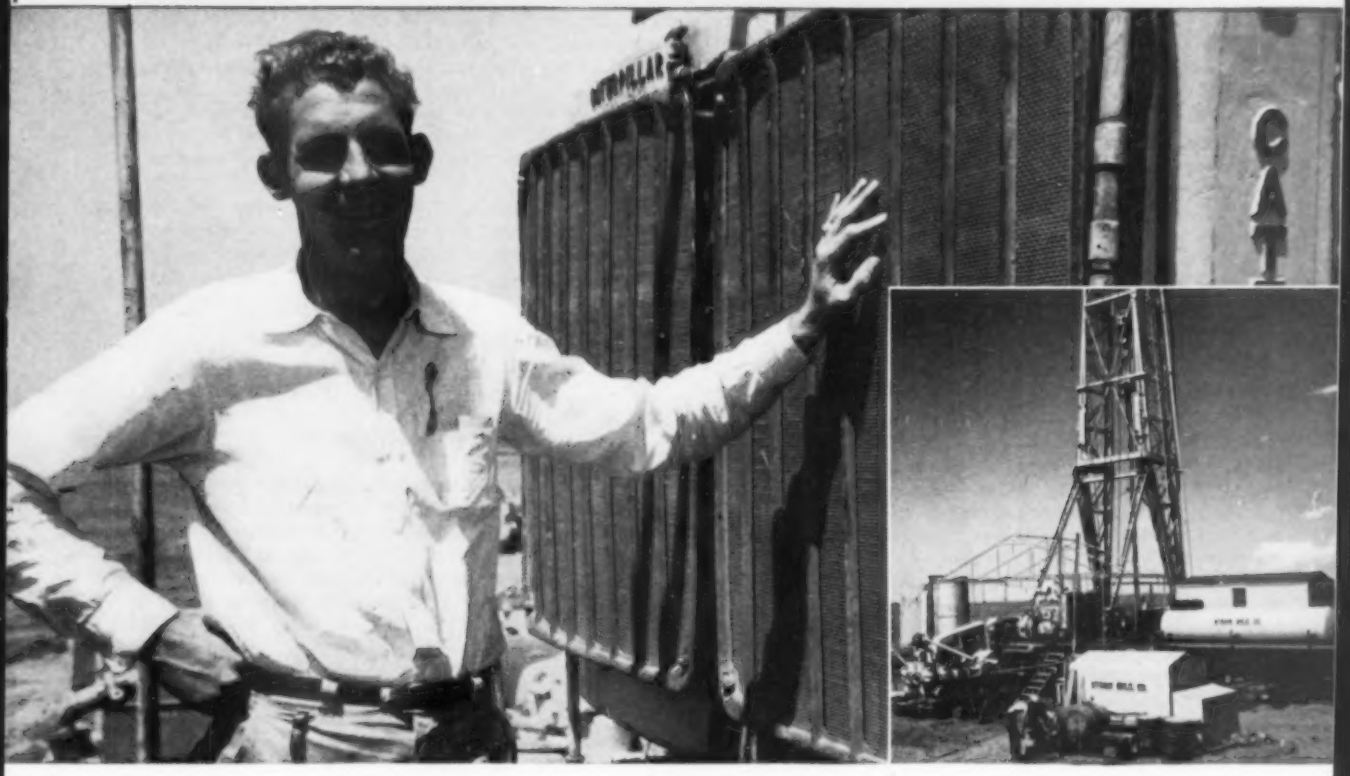
Problems in Reporting

So far, we've been defining terms and talking about procedures in report-writing. Now let's discuss some major problems we frequently run into when reporting.

ASK THE MAN WHO WORKS WITH THEM

"I find the CAT* D337 Drilling Engines trouble-free and simple to operate. They are the best drilling engines I ever used and I have been drilling for years."

George Parker, Drilling Superintendent, Strain Drilling Co., Denver, Colo.



George Parker works with two Cat D337s on the Strain Drilling Co. rig, drilling south of Fort Morgan, Colo. They power a 14-inch Gardner-Denver mud pump and draw works. He is drilling to a depth of 6000 feet.

And now these modern, heavy-duty engines are even better. The new D337 (Series F) equipped with a Turbocharger is a 310 HP (maximum output capacity) engine. The Turbocharger uses energy from the engine exhaust gases to pack more air into the cylinders. This makes it possible to take more power from the engine. Since the energy that drives the Turbocharger would ordinarily be wasted, you get greater efficiency and economy.

Parker liked the fact that the four-cycle D337 is simple to operate. The new engine is even more so. There are hydraulic valve lifters which eliminate the need for periodic valve adjustments. There's a new valve train design which provides extremely accurate control of valve motion.

The fuel system requires no field adjustments.

And equipped with torque converter, the speed and output of this Caterpillar Engine is automatically matched to the load. You get quick round trips because they apply full power rapidly and smoothly when coming out of the hole.

Rugged Caterpillar Oilfield Engines range up to 650 HP (maximum output capacity). There is also a full line of electric sets. You'll find Caterpillar Dealers everywhere in the oilfields. See your nearby dealer now for the right power to meet your drilling needs.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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MODERN HEAVY-DUTY OILFIELD ENGINES

1. Get Your Assignment Straight.

Often slighted or overlooked, this first step in report-writing is important. Maybe you've spent weeks on a written report, only to hear: "That's not what I meant! The thing I've got to find out is — "

Why not get your assignment down in writing?

If it's given over the phone or in person, jot it down and read it back. This is your certificate of understanding. If given by memo or letter, it may not be wholly clear. Whatever you do, clarify the assignment before you plunge into work — or you may have it all to do over.

2. Watch Your Timing.

Proper timing is basic to good reporting. Knowing *when* to report on *what* amounts to that rare sixth sense, intuition. The wise reporter deals with problems that (a) are relevant, (b) need attention right now, and (c) are within his realm and power to help solve.

A forward pass has to be timed exactly right — or it's never completed. Just so, a report must arrive neither too early nor too late; but no formula works in all cases because of fast-changing factors. You can never get financial or operating reports in too early to suit management; and a report that's too late is worthless — like closing the barn door after the horse is stolen. You know that.

A good policy is: *report something now*, but don't expect a goal every time you shoot for one.

3. Who's Going To Read It?

If only the writer knew! You write for one man, but others read it. You send the original to your boss and a dozen duplicate copies to others on the management team, yet an expert outside the company may read it.

I find two extremes among those who read reports: (1) the man who wants *all the background and every detail* down to the gnat's eyebrow; and (2) the man who wants *only the relevant facts of immediate help* but will call for the substantiating details as he needs them. Try to write one report to satisfy both these men, and you find yourself between the devil and the deep blue sea!

My advice is: follow Aristotle's doctrine of the golden mean by striking a happy medium. If you must err, err on the side of giving too much. And stay loaded — in case the boss wants more details.

4. Who's Going To Write It?

Often executives get a "hunch" about something and ask for a report — to corroborate their preconceived judgment. If the report doesn't substantiate their supposition, they ask for more reports on the same subject from different sources. Sometimes the report-writers catch on, get their heads together, and come up with what the executives "want!" Collusion.

Invariably, the reporters squawk about being distrusted, about duplication of work, or about executives who don't know what they want!

No manager can predetermine what he wants in a report. If he could, he wouldn't need a report. And it's pretty shrewd management to assign the same topic to men in different departments. It gives top men a more rounded picture of the problem from different approaches, as well as a basis for comparing the work and worth of their reporters.

Often several men work jointly on a report. There's nothing wrong with this — so long as one writer whips the final version into a smooth, flowing style with no repetition or overlapping.

Perhaps, as Frank W. Abrams of Standard Oil (New Jersey) said of committee management: "It stands to reason that if you get five men together and one man is wrong, the mistake is going to be picked up. Or if one man has a good idea, the others will contribute to it and develop it. And if they all have good ideas, what comes out may be better than the separate ideas together." The same's true of report-writing.

5. Sell Your Ideas.

One man may approve your report; another won't. It's easier to "sell" one man than a dozen, yet a report tries to "sell" everybody! You want to convince and persuade your readers of the facts, yes, but you should never resort to propaganda to oversell anything.

Persuasion is the art of telling somebody where to go(!) so nicely that he actually looks forward to the trip. Salesmanship is important, but don't be afraid to report: "No conclusions are warranted by the material in this study."

Report writing offers excellent training in objective thinking because it should exclude your feelings on the problem, action, object, or material discussed. It's no place for inferences; it's no place for colorations that unduly influence; and it's no place for prejudicial hints that stop all further study and investigation.

A report should be proved and verified by facts. That shuts out a lot of hot air and propaganda while it also reveals how little we really want to be impartial, especially where our personal interests are involved. An honest report, however, slants both favorable and unfavorable judgments so they reveal the truth.

The best way to sell your report is to have abiding faith in it. Then keep your main ideas before the reader so he can't escape seeing them, believing them, and coming to the same conclusions you've come to.

6. Complete Your Work by Yourself.

During World War II, certain branches of our military used a method of report-writing called "Completed Staff Work." That method might also prove useful in business.

It works like this: the staff writer is assigned a problem to investigate. The more difficult the problem, the more prone he is to run with it piecemeal to his manager or boss to discuss its perplexing details. That's exactly what the writer should *not* do!

You should consult all available sources and records on your own. You should study, write, restudy, and rewrite until you complete the report by yourself. Don't worry your boss with questions or long discussions. It's so easy to ask him what to do, and it appears so easy for him to answer. Resist that impulse! You'll succumb to it only if you don't know your job. Present your report (or memo) to him only *in finished form* — ready for his approval or disapproval.

"Completed staff work" means grind and growth for you, but more freedom and fewer headaches for the boss. It protects him from half-baked ideas, from time-consuming paper work, and from immature oral discussions.

7. Make Suggestions Whenever You Can.

Why are some report-writers afraid to make any recommendations? If they can't speak with authority after thorough study on a subject, who can? Of course, as Alexander Pope said: "It is with narrow-minded people as with narrow-necked bottles; the less they have in them, the more noise they make in pouring it out." But truly learned men are usually quiet men.

Any boss worth his salt ought to want suggestions, even though he can't carry them out or even agree with them. But recommendations give the reporter an opportunity to exercise judgment and the boss an equal opportunity to measure it.

It is actually your job to make suggestions and advise your boss what *he* ought to do, not to ask him what *you* ought to do. He needs answers, not questions.

8. Use the First-Person Point of View.

The first-person *we* is vastly superior to the third-person *it*.

What's more, the plural *we* is usable and correct in the most formal reports — even the company's annual report to stockholders, customers, and employees.

What's the sense of saying *"It* is contemplated that" instead of *"We* contemplate?" Business writing never wants to tell *who does what!* Evasion. But we compliment everyone who helps us with a report when we say *"We* investigated this and *we* find" instead of *"It* was investigated and *it* was found."

Use of plural *we* makes writing easier, shows a sense of human cooperation, and adds authority to the report. Nothing sounds sillier than a reporter referring to himself as "the author" or "the writer." Then he really confuses all others, who think he's referring to someone besides himself!

9. Where Do Exhibits Go?

If exhibits are simple, clear, and highly relevant, you should interpolate them with your discussion in the body. You should place them right *after* their mention or description, not *before*.

But if the exhibits are extremely complex and not integrally necessary to the body, they merely slow up the reader and distract him. You should then include them in the appendix as supplementary material.

10. What's a Stenographer For?

Some reporters expect the stenographer to write up their material. "What're we paying her $400 a month for?" If she *can* write your report, you may be an unnecessary employee on the payroll.

You must assume the full responsibility for getting your material ready to type. In addition to shaping your ideas and organizing your composition, *you alone are responsible* for spelling, grammar, capitalization, punctuation, abbreviations, figures — their correctness and uniformity.

Accuracy of copy is your job as well as the stenographer's. Of course, if you have foresight and good sense, you'll train your stenographer to catch many errors, correct surface mistakes, and help you tremendously. But don't expect her to do all your work, and if there's an error in the content — don't blame the steno!

Values of Report-Writing

To you, the manager —

1. **Saves you time and trouble in gathering important facts**
2. **Helps you to solve problems and make decisions**
3. **Registers new trends, data, and events you might overlook**
4. **Gives you reliable "barometers" for measuring the company's pulse**
5. **Offers you tools for coordinating all company activities into a united, harmonious whole.**

To you, the writer —

1. **Affords you an excellent chance to sell yourself and your ideas**
2. **Shows your ability to understand, follow, and complete an assignment**
3. **Develops your power to study and investigate, select and evaluate, organize and interpret material**
4. **Tests your power to communicate clearly, concisely, and convincingly**
5. **Provides a vital link between you and management.**

A Good Report Serves Everybody

The Acid Test

Final test of your ability is simply this: if you were the boss, would you accept it and *stake your reputation* on its being correct? Would you be willing to *wager your bottom dollar* on its guiding you safely and straight?

If you would, your report's all right.

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Aerial view of Mildred Lake, on Royalite's 50,000-acre lease, halfway between Fort McMurray and the pilot plant at Bitumount. Core work indicates the Mildred Lake property to be the richest area in the oil sands. Conservative estimates place its oil reserves at one billion barrels.

Part of the oil sand pits, exposed near the pilot plant at Bitumount, Alberta. The plant was purchased by Can-Amera in 1954 from the Alberta Government. At top right is a glimpse of the Athabasca River on whose banks are rich sands which hold some 100 to 300 billion bbl of oil.

Will New Method Unlock Fabulous Oil Reserve?

One of the world's greatest treasures is 100 to 300 billion barrels of oil locked in the sands on the bank of the Athabasca River in northern Alberta. A new combine will spend $50 million in a fresh attempt to process the sands economically

WHENEVER you begin to worry that North America is running out of oil, think of the Athabasca oil sands of northern Alberta, Canada. It is probably the largest reserve of oil known to man. Estimates of its areal extent range from 8000 to 30,000 square miles and estimates of its reserves from 100 billion to 300 billion bbl.

The oil sands are exposed on the banks of the Athabasca River for 65-miles north of McMurray. In 1788, Peter Ponds, the first white man to record the findings of the oil-soaked sands saw tar oozing from the banks and saw Indians using it to gum their canoes.

Since that early date, time after time enterprisers have tried to discover some way to recover oil from the sands. So far none have been successful. Both the governments of Canada and of Alberta have made investigations. The Alberta government erected pilot plants and investigated a processing operation.

The late Max W. Ball was president of International Bitumen Company, which installed a hot water separator plant in Bitumount in the 30's. But the experimental work was never economically successful nor was a later attempt to use cold water separation instead of hot water.

In 1949, S. M. Blair, petroleum consultant, was asked by the Alberta research council to do a survey on mining procedures and costs. As a result of his report, the Alberta government held a conference on Athabasca oil in 1951 attended by 125 experts from Canada, United States, Sweden, Germany, and Brazil. Unceasing efforts to unlock the inestimable wealth of the Athabasca sands since then have not been successful.

Now a new association plans to spend $50 million on a development program using a newly designed separation program. Royalite Oil Company, Ltd. and Can-Amera Oil Sands Development Company, both of Calgary, Alberta, have worked together two years on intensive research with the Coulson centrifuge process.

The process, invented by Gordon Coulson and developed by Royalite, Can-Amera and De Laval groups, spins the sand from the oil. Oil sands are to be mined and transported to the separation plants where banks of giant centrifuges, perhaps 50 in all, will automatically separate the oil sands and minute particles of clay.

Clean waste sand will be pumped out to spoil pits on the low-lying flats along the Athabasca River. The oil, which is approximately 7 gravity (API) will be transferred to a nearby processing plant where it will undergo a coking process. It will then be pumped to a sulfur plant which will produce an estimated 140 tons of sulfur per day. The resulting crude will test 20 to 30 gravity (API) thus permitting normal flow through an oil pipeline.

Ray Althouse, president of Royalite, said that initial plans call for the construction of a separation plant and a 20,000 bbl per day processing plant on the company's 50,000 acre lease at Mildred Lake, half way between Bitumount and Fort McMurray.

This year the greatest part of the work will be in engineering design. Construction, to begin at spring breakup of this year, will be handled by Caribou Engineering Company, Calgary. During the summer of 1957 crews will clear away overburden with hydraulic water guns. Warehouses, garages, machine shops, offices and living quarters will be built, and the present temporary air strip compacted. By the summer of 1958 an estimated 1000 men are expected to be employed on the construction project.

In 1958 the processing and separating equipment will be installed and in the following year, 1959, building of

G. R. Coulson

Ray Althouse

Gordon Coulson invested in wildcatting, which he found risky and expensive. He turned to the Athabasca sands where billions of barrels of oil awaited only an economical method of separation.
Ray Althouse went to Royalite Oil from Cities Service Oil Company in 1952. He heads the firm which will spend $50 million in the new venture to develop Athabasca sands.

the plant and of a 350-mile pipeline to Edmonton is scheduled. The entire project is expected to be ready for operation by 1960.

If this new method is successful, it may be just as well that the operation will not be ready before 1960 and that the plant itself will be able to process only 20,000 bbl per day.

President Althouse says that the crude will sell to refineries at Edmonton at a premium price over natural crude because it will yield more high value products ranging from premium gasoline to jet and diesel fuel.

Royalite Oil is a fully integrated oil company and expects to absorb in the initial stages of the project the entire production of crude coming from their plant at Mildred Lake. The company has 450 marketing outlets in Western Canada.

Royalite came late into the picture. Coulson had worked out the theory of a centrifuge to separate the minute particles of fine sand, clays and water remaining in the oil. His wife's spin-dry washing machine made the first tests.

Realizing that development work required additional capital Coulson approached S. M. Paulson, president of Mill Creek Oil Company, Calgary. Paulson put up $25,000 to finance patents and further research of the centrifuge process.

In order to find equipment with which the method could be tested on a commercial scale Paulson and Coulson had a small centrifuge built by the De Laval Separator Company. Tests were encouraging and they decided to proceed with a large centrifuge. For this reason a new company, called Can-Amera Oil Sands Ltd., was formed. Directors of Can-Amera include: Harold Egan, financier, Halifax; William Casey, solicitor, New York; F. T. Barton, vice president, Jones and Laughlin Steel; Edward Skae, Equipment Manufacturing Company, Detroit; William Clay Ford, Detroit, and Eugene DuPont III of Wilmington, Delaware.

Sufficient money was raised by this group to build a 50-bbl-a-day centrifuge which in 1953 was moved to the site of the government pilot plant at Bitumount, Alberta. Sand was mined from the oil sand pit and put into the machine according to Coulson's patented method.

A 500-bbl-a-day centrifuge was constructed for them by De Laval in 1954 and shipped to Bitumount.

It became obvious that to develop a large operation, marketing was tremendously important. In order to ally itself with a fully integrated company that had the handling, refining and marketing experience and facilities, Can-Amera entered into an agreement with the Royalite Oil Company in June, 1955. The ultimate object of this agreement was the establishment of a large scale oil sand operation with Royalite as the operator.

Royalite's holdings are not the only ones under lease or permit in the great Athabasca sand area. Sun Oil Company has a 50,000-acre lease and Shell Oil Company hold a permit over 50,000 acres, both the same size as the Royalite holdings. Other companies also have interests in the area. ★ ★

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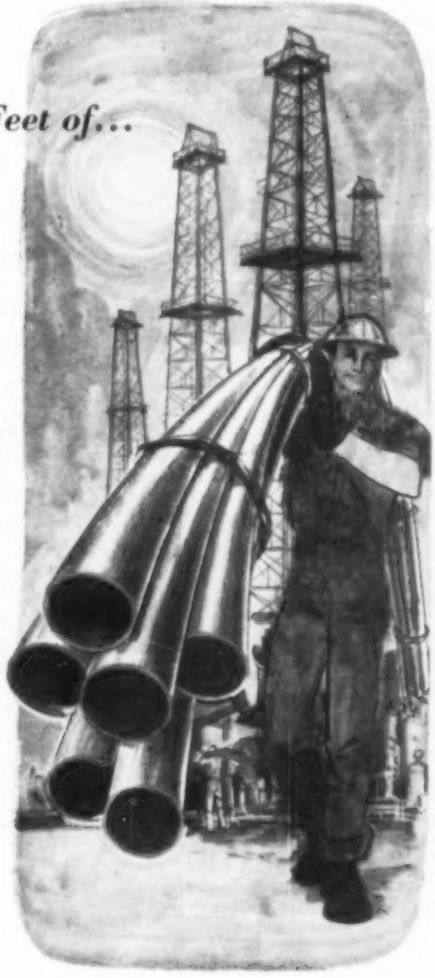

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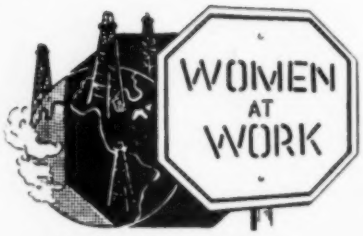

Professional Secretary

Claire R. White got into the oil industry by way of the part-time route. She was first a summer replacement for Socony-Vacuum in Boston, Massachusetts, later a temporary stenographer for Magnolia in Dallas. In 1943 when her husband, Kenneth B. White, CPA, opened offices in Dallas, Texas, Claire asked for and got a permanent position with Magnolia. She has been secretary to D. V. Carter, chief petroleum engineer, since January, 1944.

This job of "secretary" covers a broad field. Not only does Claire have regular secretarial duties, but she maintains personnel and payroll records and

Claire R. White

statistics for the 340 members of the department; supplies necessary personnel information regarding employees' records, benefits, etc. to various field office supervisors; compiles forms for employment, transfer, rate change, reclassification or termination for personnel; assists in maintaining schedules and gathering materials for projects and reports, make appointments, and interviews stenographic applicants. Even this isn't a complete list of duties.

Claire is a certified professional secretary and a member of the executives board of the Big D Chapter of National Secretaries' Association. Like most busy people, she works on community projects as enthusiastically as on her job. She does some investigation work on prisoner parole cases for the Volunteers of America, a Fort Worth, Texas, social service agency. She is a member of the Dallas Unitarian Church's board of trustees.

They have one son, Barry, now halfway through a four-year hitch as radioman on a Navy destroyer.

Born Manager

Moving to Wichita Falls, Texas, as a bride, the attractive **Mary C. Harter** saw for the first time — and she picked a big one to start on— the great Burk Burnett oil field. Mrs. Harter didn't know it then but from that time on her husband and she were never far from the oil country and were always tied to the industry.

Charles B. Harter was a pioneer in the welding industry. He had engaged

Mary C. Harter

in the oxygen gas business in Kansas City before organizing a similar company in Tulsa. At one time he opened and operated four firms under the name of The Welders Supply Company, with headquarters in Tulsa and plants in Oklahoma City, Dallas and Houston. He organized H&M Pipe Beveling Machine Company in 1935, which grew into a thriving oil field equipment manufacturing firm.

After her husband's death in 1950, Mrs. Harter inherited H&M. She had only a general knowledge of the business but she pitched in and went to work. She must be a born manager because there has been no faltering in the steady growth of the company under her capable direction. You seldom see a woman attempt management of this type of manufacturing business but courageous Mrs. Harter faced the only future she saw and took on a new and strange experience.

She can demonstrate the operation on the pipe beveling and cutting machines. She can cut a section of pipe on the machine and bevel it in the same operation quickly and easily to prepare the pipe for welding.

Her main interest outside of the oil industry is music. She is a member of the Hyechka Music Club and an ardent worker in the Tulsa Philharmonic Society. She is also a member of the American History Forum Club, a women's study club, and Pro America, Tulsa unit, which is interested in governmental affairs as well as cultural and civic affairs in Tulsa.

PERSONALS

W. G. Skelly, president of Skelly Oil Company, has resigned to become chairman of the board. **J. S. Freeman,** senior vice president has been elected president. He was nominated by Skelly.

Skelly announced he would remain active in company affairs. He founded the company in 1919. Freeman has been with the company since 1922.

W. G. Skelly

J. S. Freeman

William K. Warren, chairman of the board and chief executive officer of Warren Petroleum Corporation, Tulsa, Oklahoma, has been presented a special medallion by President Dwight D. Eisenhower.

William M. Holaday, formerly head of the research and development activities of Socony Mobil Oil Company, Inc., is leaving the company to become Deputy Assistant Secretary of Defense.

R. R. Dean

W. E. Scott

R. R. Dean, formerly vice president of Tennessee Gas Transmission Company, was named senior vice president in charge of manufacturing and marketing. **Wilton E. Scott,** exploration manager, was elected vice president.

A. F. Childers, Jr., formerly executive vice president of the Toklan Oil Corporation, has been elected president, succeeding **Roy B. Kelley** who has resigned.

Other executive promotions include the election of **C. K. Smith** as vice president in charge of drilling and production and the naming of **E. P. Neal,** manager of the exploration department, to vice president. Smith has been with the company over 10 years and Neal more than three years.

John Davenport, former executive assistant attorney general of Texas, has been appointed general counsel of Texas Independent Producers and Royalty Owners.

Paul G. Blazer, founder and chairman of the board of Ashland Oil and Refining Company, was designated chairman of the executive and finance committees. **Rexford S. Blazer,** president, was named chairman of the board and **Everett F. Wells,** executive vice president, to succeed him as president.

H. Wilkinson, C.M.G., president of Canadian Shell Ltd., has been appointed, effective July, 1957, a managing director of the Shell Petroleum Company, Ltd., and a principal director of N. V. de Bataafsche Petroleum Maatschappij. He has been on the board of the "Shell" Transport and Trading Company, Ltd., since 1948, on Shell Petroleum, Ltd., since 1953, and on N. V. de Bataafsche Petroleum Maatschappij board since 1954.

Sir Francis Hopwood, a managing director of Shell and a principal director of N. V. de Bataafsche, the two parent operating companies of the Royal Dutch/Shell group, is retiring June, 1957.

Sir Francis will remain a managing director of the "Shell" Transport and Trading Company, Ltd., and a director of the Shell Petroleum Company, Ltd.

Compania Shell de Venezuela, Ltd., announces that **Ian Davidson** will be resigning the presidency of that company as of June, 1957, although he will remain a member of the board of directors. Davidson will be appointed president of Canadian Shell, Ltd., which has its seat in Toronto, Canada. He will be appointed to the boards of the Shell Petroleum Company, Ltd., and N. V. de Bataafsche Petroleum Maatschappij. Davidson will be succeeded as president of Compania Shell de Venezuela, Ltd., by **G. C. K. Dunsterville,** a vice president of Compania Shell de Venezuela, Ltd., since 1953.

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"Tiger Brand is the best drilling line we've ever used,"

says **E. S. Thibodeaux,** *tool pusher*

for O'Meara & Sterling

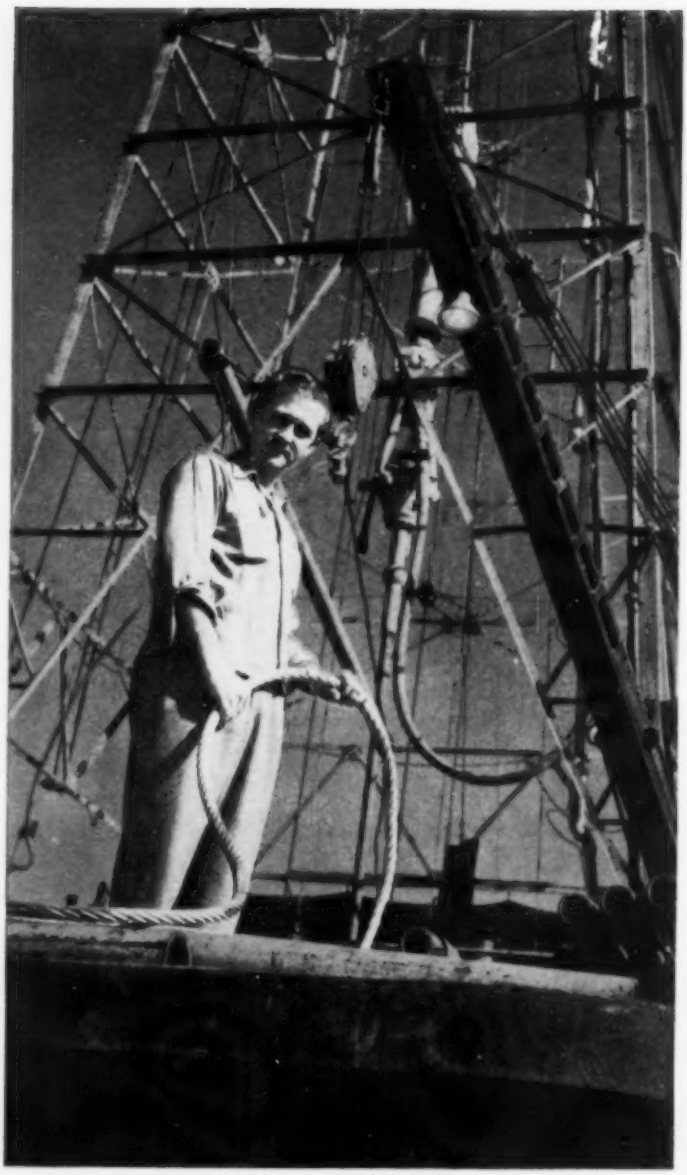
Drilling Contractors

New Orleans, La.

"We went well beyond the maximum service anticipated for any drilling line," continued Mr. Thibodeaux. He was talking about the 3500-foot Tiger Brand 1¼", 6 x 19, Monitor Improved Plow Steel Excellay IWRC drilling line installed on the O'Meara & Sterling Drilling Barge No. 1 near Timbalier Island, Louisiana.

The long service obtained from Tiger Brand drilling line is not confined to a few cases. Similar reports have been obtained from Texas, Oklahoma, Illinois—wherever Tiger Brand is used. The reasons for this are fairly simple: (1) Tiger Brand is made from the best materials obtainable and every process is carefully controlled from ore to finished product, (2) the engineering back of Tiger Brand constructions is unsurpassed in the wire rope field, (3) the Tiger Brand specialists work closely with the users and recommend the best practices to obtain maximum wire rope life.

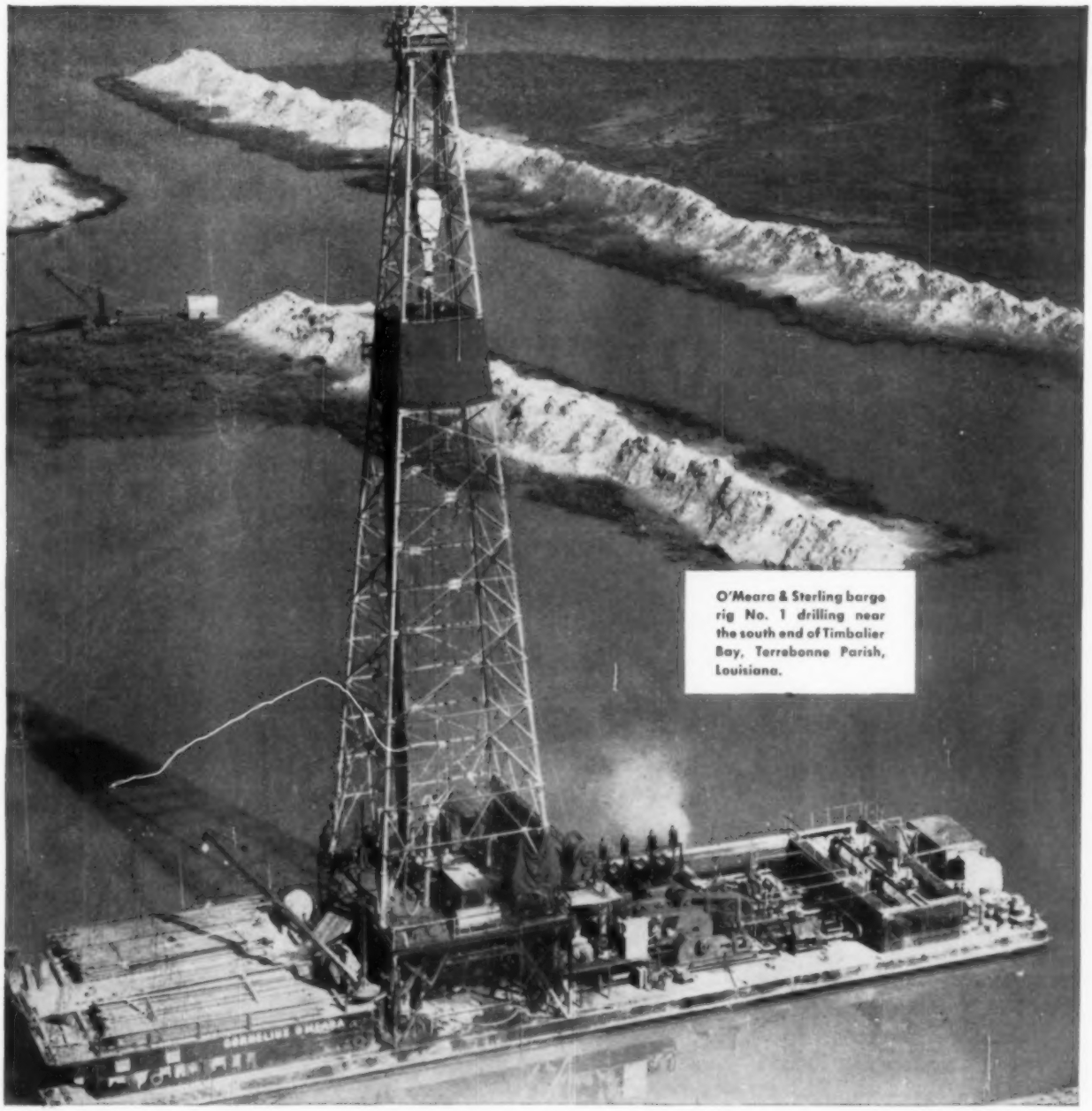
Why not rig up with Tiger Brand and check its performance on your own rig? Send for our free ton-mile calculator which makes it easy to keep accurate service records. Once you use Tiger Brand Drilling Lines, we're sure you'll be back for more.



E. S. Thibodeaux, tool pusher, says that Tiger Brand Wire Rope gave them the best service of any rope they have ever used.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Personals



O'Meara & Sterling barge rig No. 1 drilling near the south end of Timbalier Bay, Terrebonne Parish, Louisiana.

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UNITED STATES STEEL

Personals

John J. Scott, associate general counsel of Socony Mobil Oil Company, has been appointed a member of the American Petroleum Industries Committee. Scott succeeds **Austin T. Foster,** former general counsel of Socony Mobil, who has served as a member of the APIC since June, 1948.

Donald R. Skahan has been appointed director of creative activities, and **Floyd F. Ackerman** has been assigned the duties of advertising supervisor of the American Petroleum Institute's Oil Information Committee. **Peter T. Mulhare** will join the API staff as production supervisor.

D. E. Box, Jr. has been appointed chief accountant of Magnolia's producing accounting department succeeding **C. L. Houston,** who will retire April 1, 1957. **J. D. Sunkel** has succeeded Box as assistant chief accountant.

Several promotions in Phillips Petroleum Company have been announced. **John M. Houchin** was elected vice president, with duties relating generally to overall company activities but with primary responsibilities relating to the production and foreign departments. **Harry G. Fair** succeeds Houchin as chairman of the operating committee, and **W. C. Hewitt** succeeds Fair as vice chairman of this committee. **Harry D. Brookby** becomes manager of the foreign department, headquartered in Bartlesville, Oklahoma.

Datics Corporation was organized last year with headquarters in Fort Worth, Texas, to provide these services on contract: Scientific computing; data processing and reduction, and consultation.

Robert J. Ferguson, founder of Datics, is chairman of the board and administrative and organizational head. He graduated from the University of Michigan with a BA in physics, and did graduate work at Princeton University and Princeton Institute for Advanced Research.

Kenneth L. Austin, president, graduated from Western State College of Colorado with a BA in mathematics and continued graduate work at the University of Oklahoma and at UCLA. He has been an instructor, designer, and lecturer on

R. J. Ferguson

K. L. Austin

computer technology. The name of the company was suggested by his paper titled "Datics and Dataticians." He formerly was with Consolidated Engineering Corporation and ElectroData Corporation.

Oscar D. Ferris, director of operations, is responsible for the operation of data reduction, preparation and computing. He obtained his BS in physics from Texas A&M, and while part-time teaching, continued his graduate work, receiving a MS in physics. He was formerly with Battelle

O. D. Ferris

R. L. McIntire

Memorial Institute and Magnolia Petroleum Company research.

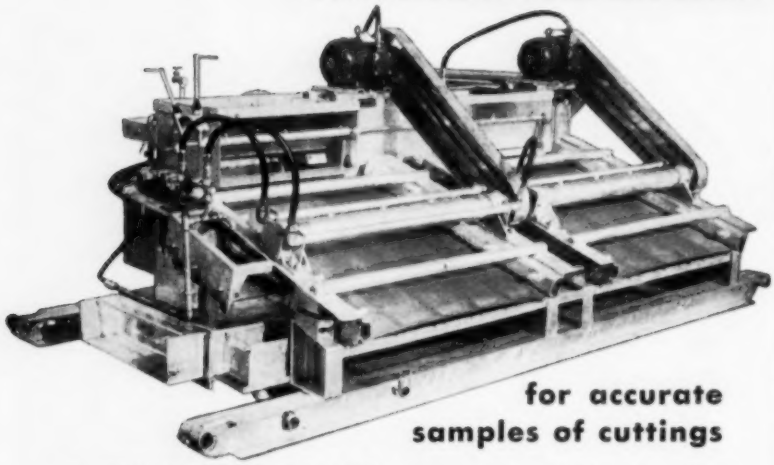
Robert L. McIntire is director of computing services. He received his BS in chemical engineering from Purdue University and a MS in chemistry from Iowa State College. He served eight years with Phillips Petroleum.

Dan W. Patterson is director of data reduction services. He was formerly with Benson-Lehner Corporation. **John M. Ryan,** director of data processing, deals with the problems of payrolls, billing, royalty payments, tax reports, inventory control, production scheduling, operations research and shipping schedules. He was with United Gas Corporation. **Jon Vinson,** datatician, is responsible for blending the required mathematics into an efficient machine program. He formerly served in the research laboratory of United Gas Corporation. **Cloyd M. Roberts,** manager of the digital computing group, is in charge of the operation and maintenance of the entire computing system. He was formerly with Texas Electric Service Company, International Business Machines Corporation, Genueral Telephone Company, and Electro Data Corporation

Anthony F. Marotta, manager of the data preparation group, is responsible for organization and operation of all data reduction and card preparation equipment in the Fort Worth installation. He previously served with Statistical Tabulating Company and the Texas Railroad Commission.

Thompson

DOUBLE VIBRATING SHALE SHAKER...and SAMPLE MACHINE



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The THOMPSON SHALE SHAKER SAMPLE MACHINE offers the operator and geologist one of the best methods available for obtaining accurate foot-by-foot samples of well cuttings.

This THOMPSON DOUBLE VIBRATING SHALE SHAKER and SAMPLE MACHINE is specially engineered for off-shore barges or islands, deep wells, or wells using big volume and high pressure mud pumps. It is available either plain or galvanized, which makes it rust and deterioration-proof on off-shore or coastal duty.

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Make sure THOMPSON'S on the job for accurate samples and clean mud.

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Personals

COMMERCIAL air transportation is one of the fastest-growing industries in America. But it should never be forgotten that with almost every new stride this industry has taken, the petroleum industry has had to be one jump ahead . . . has had to be ready with the lubricants and fuels to fit the job. We of The Texas Company are proud that our association with this vital industry has been such a long and successful one. In fact . . .

For more than 20 years, more scheduled revenue airline miles in the U. S. have been flown with Texaco Aircraft Engine Oil than with all other brands combined.

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AS AN ENGINEER

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Personals

W. Alton Jones and **Robert J. Hull** have been elected chairman of the board and president, respectively, of Cities Service Oil Company, Ltd.

Donald R. Gearhart, vice president of Sinclair Oil & Gas Company, has been elected president of Sinclair Canada Oil Company, a subsidiary of Sinclair Oil & Gas. **Walter P. Wilson** is vice president and general manager of Sinclair, Canada. **D. A. Jerome,** district landman, has been named a vice president. **Kenneth W. Germond,** formerly with Southern Production Company, has been appointed manager of exploration in Canada, and **George F. Chadburn,** former division landman for Southern, has been appointed manager of the land department.

J. C. Kelley, president elect of Petroleum Club of Los Angeles, presents memento gavel to retiring president, **Olen Lane,** in testament to his successful term.

J. C. Kelley, partner in the firm of Hillman-Kelley, was elected president of the Petroleum Club of Los Angeles. He succeeded **Olen Lane**, vice president of Continental Oil Company in charge of West Coast operations. The Club, which has its quarters in the Statler Hotel, has approximately 1000 members representing all phases of the petroleum industry. It was organized in 1948 by a group of members of the Oil Club. Other officers elected were: Vice president, **T. H. Wallace,** Western Gulf Oil Company; treasurer, **Gordon D. Campbell,** General Petroleum Corporation; secretary, **R. Sneddon,** manager of the Petroleum Club.

DEATHS

S. W. Andrews, 66, a director of The Fluor Corporation, Ltd., and president of H. G. Acres and Company, Ltd., of Niagara Falls, Ontario, a Fluor affiliate, died of a heart attack December 31.

John F. Shea, vice president in charge of sales for the Becco Chemical Division of Food Machinery and Chemical Corporation, Buffalo, New York, died November 26 at the Roswell Park Memorial Institute, in Buffalo. He was 51.

Anthony Folger, senior geologist with DeGolyer & McNaughton, consulting geologists and engineers, was among the 62 passengers on the Trans-Canadian Air Lines plane believed to have crashed over British Columbia December 9.

Fero Williams, 54, Tidewater Oil Company senior vice president, treasurer and board member, died suddenly December 24.

James J. Callahan, senior metallurgical engineer for the thermal products division of ALCO Products, Inc., died December 26 in Brooks Memorial Hospital after a long illness. Callahan was 61.

Oliver W. Craft, 54, died of a heart attack January 3. He was with the Tydol Oil Company.

William Henry Brimm, 77, of Midland, Texas, former Tulsa oilman, died January 4 of a heart attack.

Wallace J. V. Taylor, co-owner of the Band Oil Company, and a pioneer in the industries development of Signal Hill, died in Long Beach, California, December 2. He was 59. He owned the Taylor Drilling and Production Service of Long Beach.

W. R. Wardner, Sr., 78, Whittier, California, died the middle of December. He has been a producer in the Bakersfield, California, area since 1910.

Roy E. Hall, vice president of Wyatt Metal & Boiler Works, died suddenly December 9 at his rural home near Houston, Texas. He had been with the concern since 1929 and was in charge of production in Wyatt's Houston plant.

William G. Selby, 72, Sarasota, Florida, a large stockholder in the Standard Oil Companies of California and New Jersey, and The Texas Company, died during mid-December.

V. Rue (Bud) Marichal, 68, executive of Douglas Oil Company, died December 8.

Elmer E. Johnson, a retired drilling rig builder, died of a heart attack December 31. He was 77.

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Clark is now factory-installing STITT new Triple Ignitor Spark Plugs in Turbo Charged engines . . . Bring your Clark engines up to date—repower them with STITTS which give you longer life, cut downtime, increase magneto life. STITTS are also factory equipment in Waukesha, Cooper-Bessemer, Worthington, other leading engines

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BOOKS ★

Fuel Injection Systems, *by Brian P. Emerson, published by Diesel Publications, Inc., 192 Lexington Avenue, New York 16, New York. Pages, 220. Price, $2.00.*

This third edition, a revision, has taken two forms — addition of systems introduced since last publication in 1950, and expanded coverage of other systems. All new developments in fuel injection equipment are included, written so a beginner can understand, and yet including specific service data for men in injection repair shops. Eleven systems are described and illustrated. An extensive chapter is devoted to modern servicing techniques and the tooling used.

The Evolution of the Igneous Rocks, *by N. L. Bowen, published by Dover Publications, Inc., 920 Broadway, New York 19, New York. Pages, 332. Price, $3.75 cloth, $1.85 paper.*

An invaluable starting point and serious introduction to chemical geology for serious students of rock origins, this publication is an interpretation of the diversity of igneous rocks in terms of fractional crystallization. It emphasizes the physical chemistry underlying geology. Since its first publication in 1928, it has reportedly been regarded as a first-rate reference for all geologists, mineralogists, strategic mineral experts, and high-pressure physical chemists.

Ten Year Index to Corrosion, 1945-54. *Compiled by Norman E. Hamner and J. F. Van der Henst Jr. Published by the National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Texas. Price per copy, postpaid, NACE members, $5.00. All others, $7.50. Pages, 32.*

Alphabetical subject index consists of approximately 4000 reference phrases and alphabetical author index of 1056 names. Titles are included of 629 articles published in the first decade (1945-54) of publication of Corrosion, the monthly journal of the National Association of Corrosion Engineers. The subject index, organized around the system developed for the NACE Abstract Filing Index, is intended to be of maximum service to the general corrosion worker.

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LAUGH with BARNEY

A young Miss called the police department and said she had been assaulted. "When did this happen, Miss?" the officer asked.

"Last week," she replied.

"Last week! Why didn't you call us right after it happened?" the officer exclaimed.

"Well," she said, "I didn't know I had been assaulted until his check bounced."

Once a king, always a king but
Once a knight's enough.

"What does the report show, Doc?"

"This analysis," said the doctor, "shows that there is every indication that a small percentage of blood is getting in your alcohol stream."

If you would speak for all to hear avoid
the flowing cup,
For after too much bottled cheer your
tang gets toungled up.

"Sir," said the young man to his girl's father, "as you know, I have been seeing a lot of your daughter."

"Yes, yes, son," he interrupted. "Do you want to ask for her hand?"

"Well, sir, the fact of the matter is that I would like to get off the hook."

When he met the ex-wife at a party and they had had a few drinks he suggested that they have another try at marriage.

She sneered: "Over my dead body."

He sneered: "So you haven't changed a bit."

Troubled with a sore throat, he rushed to the doctor's home. The doc's pretty blonde wife answered the door.

"Is the doctor in?" he asked hoarsely.

"No, come in," she whispered back.

Often wondered where mothers learned those things they tell their daughters not to do.

With a charming air of romance and pleasant sentimentality, the company was discussing how each married couple among them first met.

"And where did you first meet your wife?" the little man in the corner was asked.

"Gentlemen, I did not meet her," he replied solemnly, "she overtook me."

To get into television these days, a girl has to know somebody or have some body.

The editor was chiding his son because of the boy's poor grades at school. "If you don't study hard," admonished the editor, "you'll never get to be a good editor, you know. What would you do, for instance, if your magazine came out full of mistakes?"

"Why, dad," was the reply, "that's simple. I'd blame the printer."

And the father wept with joy, because he knew that he had a worthy successor for the editorial chair.

He who speaks by the yard, thinks by the inch, should be dealt with by the foot.

Notice in doctor's office: "Ladies in waiting room are asked not to exchange symptoms. It gets the doctor hopelessly mixed up."

Teacher: Can anyone tell me the main use for cowhide?

Johnny: It keeps the cow together, ma'am.

One stenographer to another: "You'll like it here—lots of opportunity for advances."

A white-haired old man approached his doctor and said: "Doc, I'm slowly going nuts over women. Is there any way to speed it up?"

"What kind of saddle do you want?" the cowboy asked the dude. "With or without a horn?"

The dude pondered a moment before answering: "Without, I guess. Doesn't seem to be much traffic on these prairies."

A woman's declining years are before she's 30. She'll accept almost anybody after that.

Work Fast: Up to now your work has been half-fast.

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FISHING & RENTAL TOOL SERVICE THROUGHOUT THE SOUTHWEST
Acme's service men have a thorough knowledge of Mid-Continent Drilling and Production problems and methods. Acme manufactures fishing tools, rents 'em, and maintains general oil field machine shops. For a job well done . . . right now . . . call ACME!
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DIG 17¾ FEET DEEP with Koehring ½-yard hoe

There are several reasons why you should look into this heavy-duty ½-yard hoe. For one thing, you get exceptiona!ly wide work range on trenches, slush pits, footings and other below-grade excavations. It digs 17¾ feet below crawlers. Long reach puts spoil bank well beyond edge of cut — and gives up to 8¾ foot clearance height (at beginning of dump) to load trucks. ½-yard dipper makes a wide cut — 31 inches over side-cutters. During dig-and-swing cycle, close-coupled dipper pulls up tight to boom, avoids spillage as boom swings out of the cut.

Behind the Koehring 205's powerful cable crowd, fast line and swing speeds is plenty of *reserve* strength for heaviest digging assignments. Big, 20-inch main-drum clutches are among the largest used in the ½-yard class. Antifriction power-flow on dig, hoist, swing and travel assures smooth, dependable operation under maximum loads. Automatic traction brakes simplify operation — safely lock and hold the 205 when working or parked. Operators like the 205's ease of operation. You'll like the *extra work capacity* you get with every attachment. For example —

This big-capacity 205 readily converts from hoe to ½-yard shovel, handles ½ to ¾-yard clamshell or dragline buckets on a wide work radius — has 10-ton capacity as a crawler-mounted crane. It's available with all standard attachments on 32½ m.p.h. truck mounting. Koehring 205 truck crane has 15-ton capacity. Better look into this heavy-duty 205 soon. Ask your Koehring distributor to demonstrate what it will do for you. See him, or write us. (Four larger sizes of excavators and cranes also available in the Koehring line.)

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K561

• Industry
• People
• News

The Trade PARADE

New Fracture Process Agreement Made

The Western Company and Chemical Process, a division of BJ Service, Inc., have entered into a cross-licensing agreement on the new Perforation Sealing Process for oil well fracturing and acidizing.

Under the terms of the agreement, BJ Service will be responsible for licensing other oil well service companies to perform these processes using the combined patent rights and technical development of both Western and BJ Service. The Western Company will be primarily responsible for research and development of the improved equipment and techniques. Both companies will continue to offer the service through their established field outlets.

Patented method uses small-diameter balls which are injected into the fracturing or acidizing fluid being pumped into perforated pay zones. Balls plug perforations having high permeability and divert fracturing fluids into less permeable or tight zones.

New Cameron Plant in England

Cameron Iron Works, Ltd., of Leeds, England, a subsidiary of Cameron Iron Works, Inc., of Houston, Texas, is constructing a new factory, warehouse, and office facility at Stourton, near Leeds, England. Plant superintendent for the operation will be Edward E. Parker of Huntsville, Texas. Plant is to be in full operation by September, manufacturing Cameron oil well drilling and production control equipment.

IBM To Sell Machines

International Business Machines Corporation offers its electric accounting machines and data processing machines under two new marketing plans.

In accordance with a consent judgment entered into between IBM and the Department of Justice, new machines currently offered for lease will also be offered for outright purchase. Announcement marks a major change in the company's policy of only offering its machines on a rental basis.

The company also has offered to sell, for a limited time, machines now installed or those soon to be installed.

UOP Launches Counsel Service

Universal Oil Products Company has established a market research and economics department to help industry solve problems of plant expansion, modernization, and new refineries.

Named to head the department is Samuel W. Curry, petroleum economics specialist with six years' experience in UOP sales and marketing posts.

Functions of the department include marketing studies of projected demand for any refinery product, analysis of economic potential of processes and equipment, and estimates of future price and production trends. Financial studies of the value of existing refineries also are made by the department.

Celebrate 50 Years' Service with American Meter Company. Norton McKean, director of American Meter, center, presents cash awards to four employees each with 50 years at the company. They are, left to right, Leo Rivers, James J. Cooney, Joseph F. Miles, and John Lyman. Awards were made at a banquet in Albany, New York.

AMF Acquires J. B. Beaird

American Machine & Foundry Company has acquired J. B. Beaird Company, Inc., of Shreveport, Louisiana, manufacturer of LP gas systems and package compressors for the oil and gas industry.

Involved in the merger was a transfer of stock — Beaird's 10,000 shares for approximately 155,000 shares of American Machine & Foundry stock. AMF, a large diversified manufacturing firm, expects gross sales and rentals for 1956 to total around $200,000,000 compared to $20,000,000 for the Shreveport company. No change in corporate name, operating policy or personnel is planned for the Beaird company.

Tubular Lining Firm

Formation of Tubular Lining Corporation, a new Houston, Texas, firm which will specialize in the application of corrosion-resistant plastic linings to the interior of oil field tubing has been announced.

Construction has begun on the plant, which is being equipped with special machinery that will automatically apply linings to 5000 lineal feet of tubing each working shift. Working at full capacity of the initial unit, 1,800,000 ft of tubing can be lined per year.

Firm Realigns Divisions

Motorola Inc., has elected Paul V. Galvin chairman of the board of directors. Robert W. Galvin, formerly executive vice president, was named president.

Five newly defined major products divisions — consumer, automotive, industrial, semi-conductor and military products — were established also. Daniel E. Noble was elected executive vice president in charge of the communications and industrial electronics division, the semi-conductor products division, and the military electronics division. Arthur L. Reese was advanced to vice president and general manager of the new communications and industrial electronics division.

Other promotions for the industrial division included: Roy Olson, to manager, microwave and industrial control products department; Augus Macdonald to director of engineering, and William Weisz, to chief engineer of the mobile and portable communications products engineering department.

Fibercast Distributors

The Fibercast Corporation has appointed Continental-Emsco Company as oilfield distributors of its Fibercast Line Pipe and Well Tubing. The Fibercast Corporation, Sand Springs, Oklahoma, is a subsidiary of The Youngstown Sheet and Tube Company. In addition, current expansion of Fibercast's plant will increase production of both line pipe and well tubing tenfold within the next several months.

Pacific PESA to Meet

Plans have been completed for the Petroleum Equipment Suppliers Association's 1957 Pacific District spring meeting February 6 at the Ambassador Hotel, Los Angeles, California. Highlight of the one-day meeting will be talks by guest speakers Fred Hanson, vice president, California Bank, Los Angeles, and Joe Shell, California State Assemblyman, Fifty-Eighth District, Los Angeles.

Homelite Plans New Plant. Homelite, a division of Textron Inc., has broken ground for a modern chain saw plant in Gastonia, North Carolina. Plant will be completed during the summer, at which time Homelite will transfer its chain saw production from Port Chester, New York, to Gastonia. The new plant will have between 400 and 500 employees.

McCann To Head Johnston Testers

D. C. McCann has been appointed president of Schlumberger Well Surveying Corporation's subsidiary, Johnston Testers. M. O. Johnston, founder of the company, and formerly president and chairman of the board, will continue to serve as board chairman.

Everett F. Stratton, formerly Southwest area manager, succeeds McCann as vice president of operations for Schlumberger.

In other moves, Louis E. Magne assumes the position of Southwest area manager in Houston, Texas; William R. Mills has been transferred to South Texas as division manager, San Antonio, Texas, and William M. Pickles Jr. has been named administrative assistant to the executive vice president of Schlumberger.

D. C. McCann

E. F. Stratton

NEWS NOTES

COINCIDING WITH ITS TWENTY-fifth business year, the DeZurik Shower Company of Sartell, Minnesota, has changed its corporate name to DeZurik Corporation.

ESTABLISHMENT OF A NEW OIL field equipment sales and stocking point in Houston, Texas, has been announced by Delta Tank Manufacturing Company, Inc. Frank M. Black has been appointed Houston area branch manager.

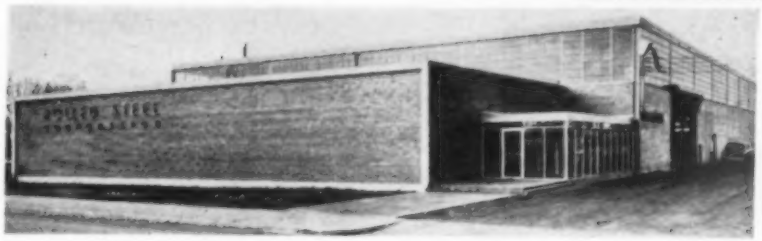
AIR REDUCTION SALES COMPANY, a division of Air Reduction Company, Inc., has announced the company's acquisition of the assets and business of Jackson Products, Inc., of Detroit, Michigan.

THE MAJORITY OF SPACE ON THE twenty-fourth floor of the Bank of the Southwest Building in Houston, Texas, has been acquired by the sales department of the Houston Oil Field Material Company, Inc.

ROYSTON LABORATORIES, INC., has combined its sales offices serving the Texas, Louisiana, Arkansas, and Mississippi area into one office at Houston, Texas. W. R. Curley is the new regional manager.

WEB WILSON OIL TOOLS, INC., HAS opened a warehouse to serve the Mid-Continent and Gulf Coast areas, at Dallas, Texas, with Hubert L. Arrowood in charge. Ray E. Gorman, Mid-Continent division sales manager, will make his headquarters in Dallas at the new address.

ACME OIL TOOL COMPANY CON-tinues expansion by adding tenth plant in South Edmonton, Alberta, Canada. The promotion of Wayne Sanderson to manager of the new branch also has been announced.

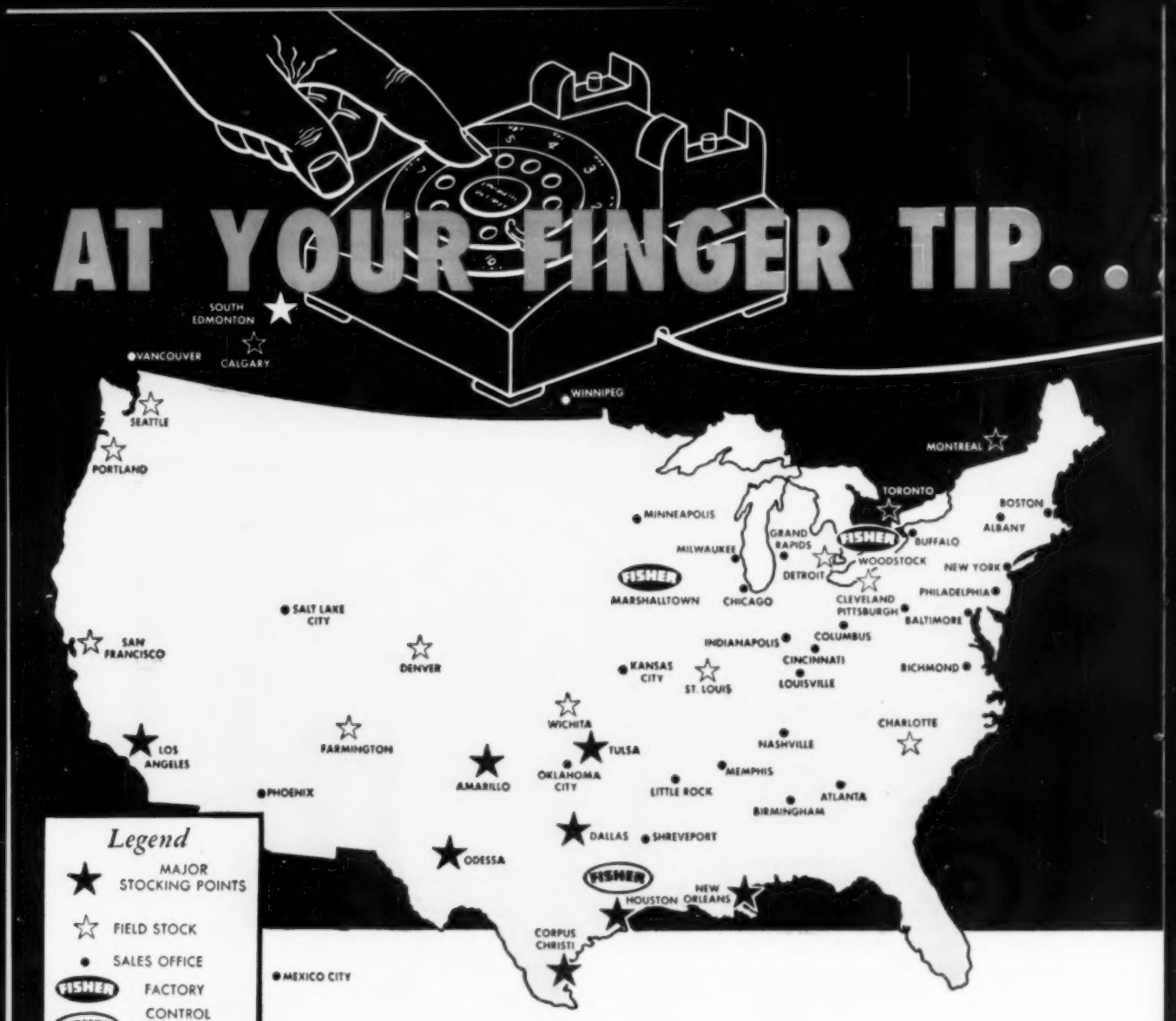


Unique Plant Opened

Rolled Steel Corporation, supplier of sheet steel to the petroleum industry, has opened a new Skokie, Illinois, plant, which more than doubles the company's facilities.

Office area is built around a large sales office in which the company's salesmen are seated at desks facing a chalk board that contains a moment-by-moment report of the company's inventory. About five feet above this floor is a row of glass-walled executive offices. From these offices, company officials have a clear view of both sales office and plant operation.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



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World Leader In Research for Better Pressure and Liquid Level Control

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HOUSTON
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J. F. Schultz & Co.
MONTREAL
Process & Steam Specialties, Inc.
NASHVILLE
Johnson & Scott
NEW ORLEANS
John H. Carter Co.
NEW YORK (ENGLEWOOD CLIFFS, N. J.)
Crabbe & Stebbins Co.
ODESSA
Vinson Supply Co.
OKLAHOMA CITY
Vinson Supply Co.
PHILADELPHIA (NARBERTH)
C. B. Ives & Co., Inc.
PHOENIX
Cone & Wallace Co.
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Barrett & Yost
SHREVEPORT
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SOUTH EDMONTON
Barber Engineering & Supply Co.
ST. LOUIS
H. D. Hale & Co.
TORONTO
G. W. Beecroft Co., Ltd.
TULSA
Vinson Supply Co.
VANCOUVER
Northern Columbia Process Equip., Ltd.
WICHITA
Sullivan-Mears Company
WINNIPEG
Mechanical Valve & Engineering Specialties
WOODSTOCK
Fisher Governor Co.

PRESSURE REGULATORS

GAS REGULATORS

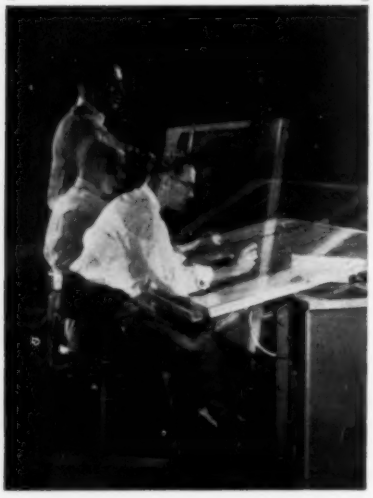
LIQUID LEVEL CONTROLLERS

DIAPHRAGM CONTROL VALVES

PUMP GOVERNORS

LEVER AND FLOAT VALVES

Why Hamilton Auto-Shift drafting tables save you money



Draftsmen with Auto-Shift tables *produce more*. Two simple controls adjust board height and slope so easily that working angle can be frequently changed—board is instantly, effortlessly shifted to most convenient working position.

And Auto-Shift tables put *more draftsmen* to work in available space. Designed for row installations, there's a reference desk behind each draftsman. *Six* men work where *four* do now! Get the whole story—write Auto-Shift, Hamilton Manufacturing Company, Two Rivers, Wisconsin.

Hamilton

drafting equipment

J. C. Ballagy, president of Jet-Lube (left), and J. B. Curry, managing director of A. B. C. Coupler & Engineering sign manufacturing license agreement.

Jet-Lube Grants License

Jet-Lube, Inc., has granted a manufacturing license to A.B.C. Coupler & Engineering Company, Ltd., of London, England, for the manufacture of Jet-Lube's tool joint and pipe thread compounds and extreme-service greases and oils. Frank E. Bergeron, vice president and general manager of Jet-Lube, will supervise installation of machinery and the initial production at the Wolverhampton, England, plant.

PEOPLE

Charles R. Perry has been appointed research and development engineer for Sivalls Tanks, Inc., with headquarters in Odessa, Texas.

Jack F. Spaulding has been made purchasing agent for Cleveland Diesel Engine Division, General Motors Corporation. Spaulding succeeds **A. O. Cash,** who is retiring after 31 years at Cleveland Diesel.

John W. Little has been elected president of Goslin-Birmingham Manufacturing Company, Birmingham, Alabama, to succeed **Joseph T. Hartson,** who has retired. Little was also made a member of the board of directors.

Henry J. Murphy Jr. has been named sales representative for The Brewster Company, Shreveport, Louisiana.

H. J. Murphy Jr.

R. G. Greer

Ralph G. Greer has been appointed assistant sales manager of the construction equipment division of International Harvester Company, succeeding **C. E. Jones,** who is supervisor of national contractors' sales.

Philip J. Olmstead has been appointed chief engineer of Goulds Pumps, Inc.

W. L. (Bill) Phillips has been named sales and service engineer for the Hardy-Griffin Engineering Corporation, Houston, Texas.

Edward W. (Red) Lawlor has been appointed manager of the newly created Tulsa, Oklahoma, office of The Holcombe Company, Inc.

EASY TO READ MARKINGS THAT ARE DURABLE
DESIGNED FOR MAXIMUM ON-THE-JOB SERVICE
LUFKIN
CHROME CLAD "DERRICK" TAPE
Rugged service and dependable accuracy are carefully built into this fine tape. Narrow, sturdy line, with genuine Chrome Clad finish, is rust and corrosion resistant. Rollers in frame, oversize drum, and extra long handle provide extra leverage and quick, easy rewinding. Block hook with ribbed face quickly positions tape at zero for accurate measure. These are but a few of the Lufkin features that assure maximum on-the-job service.
BUY LUFKIN TAPES • RULES • PRECISION TOOLS FROM YOUR SUPPLY HOUSE
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New York City
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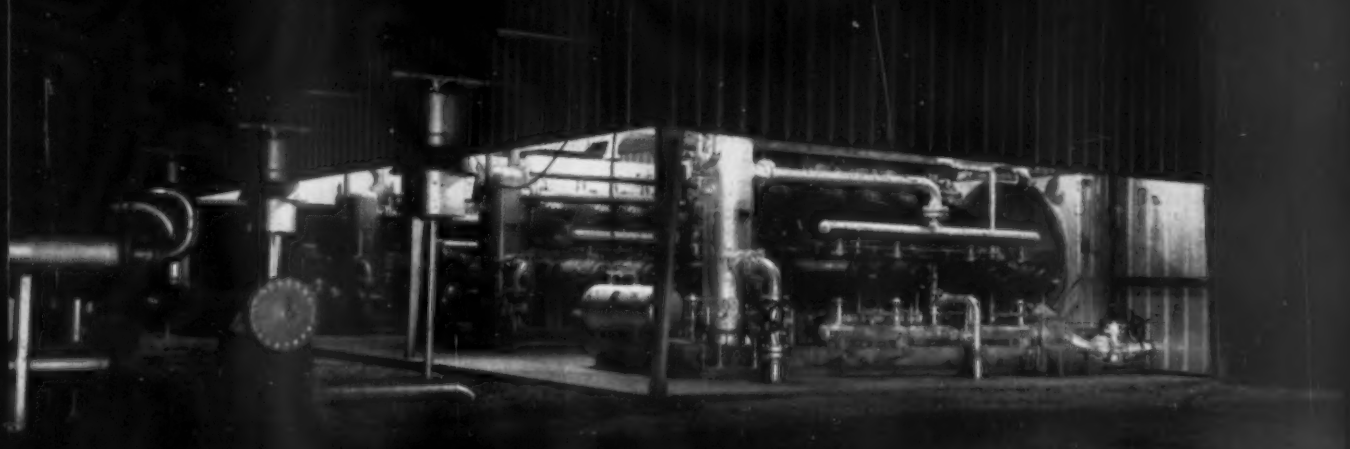
BETTER MEASURE WITH LUFKIN
390

BEAIRD-INGERSOLL-RAND
Packaged Compressor Plant

Lowest Cost Per Horsepower Installed



NATURAL GAS AND OIL COMPANY'S SLIGO FIELD STATION—equipped with three Beaird-Ingersoll-Rand 10SVG 550 h.p. packaged compressors, Young Radiators with lubricating oil coolers, gas coolers and all necessary controls. Other sizes 110 to 660 h.p.

Natural Gas and Oil Company has twice expanded this compressor station in Sligo Field, Louisiana. Originally it was equipped with a single Beaird-Ingersoll-Rand 10SVG 550 h.p. compressor. In designing the station the engineers provided the space and piping to accommodate units that would be added on as needed. Now picking up gas from 24 low pressure wells at 650 psig. the station is boosting from 40 mmcfd to 50 mmcfd to transmission lines at 1050 psig. The last unit installed in August of this year will enable the station to follow the pressure on down to 200 psig. without change from single-stage operation. At this point in production the units will be changed in the field to two-stage operation. And finally as the field nears depletion, one or two of the compressor plants may be transferred as a complete package to another site, leaving the remaining plant to complete production.

Let us show you the versatility possible with packaged compressors designed for your production needs.

Versatile Packaged Compressors–

SOLUTION FOR EXPANDING STATION

BEAIRD MACHINING MANUFACTURING STEEL WAREHOUSE

THE J. B. BEAIRD COMPANY, INC.

PACKAGED COMPRESSOR PLANTS

CAST STEEL FITTINGS

PRESSURE BULK STORAGE

ANHYDROUS AMMONIA EQUIPMENT

LP-GAS SYSTEMS

SHREVEPORT, LOUISIANA • Sales Offices: *Dallas, Houston, Corpus Christi and Midland, Texas* • *New Orleans, Louisiana* • *Tulsa, Oklahoma* • *Denver, Colorado* • *Los Angeles, California, and Cie. Ingersoll-Rand, Paris, France*

BEAIRD FITTINGS...

THE RIGHT TURN FOR SEAGOING OIL!

Weighing twenty six hundred pounds each, these 24″ Beaird cast steel fittings have gone to work delivering Venezuelan oil to waiting tankers. Another example of precision manufacturing from blueprint to finished product, the big cast steel flanged elbow fittings were produced to exacting specifications by Beaird's machining division. One of five divisions serving the oil, gas, petro-chemical and construction industries, the machining division offers its customers the benefits of the integrated facilities and know-how of the entire Beaird production team.

BEAIRD

Let us quote on your next outside machining or special product requirement. Write: The J. B. Beaird Company, Inc., Shreveport, Louisiana.

THE J. B. BEAIRD COMPANY, INC.

MACHINING
MANUFACTURING
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PACKAGED COMPRESSOR PLANTS | CAST STEEL FITTINGS | PRESSURE BULK STORAGE | ANHYDROUS AMMONIA EQUIPMENT | LP-GAS SYSTEMS

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NOT EVEN FIVE FEET OF PEAT BOG CAN HANG UP THE NO. 583

The Cat* No. 583 Pipelayer is not only the highest capacity pipelayer in history—but the most efficient. Mannix Ltd., Calgary, Alberta, has four of them in its 100% Caterpillar spread laying 110 miles of 30-inch gas line through southern British Columbia.

The line takes the No. 583s through 40 miles of reclaimed lake bottom, covered with heavy silt and peat bog four to six feet deep. But the No. 583 has a full 21-inch ground clearance, and the bog can't stop it.

These big yellow units were engineered to give you a full day's work no matter what the terrain. For this machine was designed after consulting spread superintendents, foremen, mechanics and operators throughout the industry. It incorporates all their ideas of the ideal pipelayer. As a result you have the first machine that is *all pipelayer*.

It has 130,000-lb. lifting capacity and its engine delivers 191 HP. There is a three-stage torque converter in the main drive and new hydraulically actuated counterweights. And the extra high bottom clearance of the counterweight pivot, coupled with the ability to retract the counterweights well over the tracks, means that the No. 583 can maneuver easily even while handling an extra heavy load on a narrow right of way.

Here's the safest, fastest, most efficient machine ever designed for pipelaying. Behind it stand an army of Caterpillar Dealers always ready to give you quick service with quality factory parts wherever the pipe takes you. Call your Caterpillar Dealer today. You name the date—and he will demonstrate on *your* job.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

WANTED—THE HARD WORK

Win-Well Manufacturing Company has appointed **Lee Snodgrass,** owner of Lee Snodgrass Company of Los Angeles, California, and **Waymon L. Davis** and **William R. Marler,** partners in General Well Testing Company of Shreveport, Louisiana, as sales representatives for their respective areas. **C. C. Pryor** has been named sales representative for Win-Well in the Gulf Coast area.

Frank F. Elliott has been designated chairman of the board of directors of Crane Company. He will be succeeded as president of the company by **Neele E. Stearns,** currently vice president for planning and development of the Inland Steel Company.

Arch F. Campbell, manager of engine sales for Detroit Diesel Engine Division of General Motors Corporation, has retired after 37 years' association with the petroleum industry.

John R. Pinkerton has been appointed sales-service representative in Great Bend, Kansas, for Rector Well Equipment Company, Inc.

J. R. Pinkerton

R. E. Moore

Robert E. Moore has been appointed a sales engineer by Rawson & Company of Houston, Texas.

A. J. Komich

R. B. Kitzmiller

Robert B. Kitzmiller has been named Los Angeles, California, district sales manager and **A. J. Komich** has become gas products manager of Rockwell Manufacturing Company's meter and valve division. **Joseph A. Heiman** has been made purchasing agent for Rockwell's instrument division at Tulsa, Oklahoma.

Carl H. Herrell has been named manager of oil field sales for California Construction Company, Los Angeles, California.

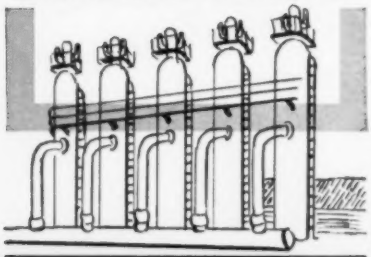
Four new appointments in the Burgess-Manning Company, Penn Instruments division, are: **R. J. Medkeff,** to chief engineer; **William Melas,** consulting engineer; **Adalbert Melas,** service manager, and **Clifford C. Harris,** assistant secretary.

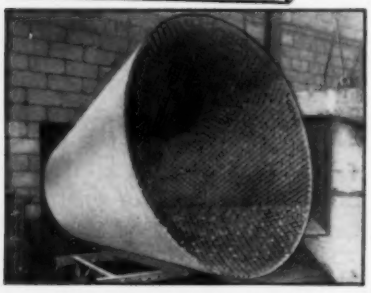
William H. Gutlerl has been named assistant to the general manager of sales of American Steel & Wire.

Charles D. Duffy has been named general traffic manager of Westinghouse Electric Corporation.

R. B. Meripol has been appointed assistant sales manager of Macco Oil Tool Company, Inc.

FEWER "TURN-AROUNDS"





Shutdowns for repairs of fire clay linings in refractory units are expensive. The frequency and duration of these shutdowns can be greatly reduced by the use of a steel grating armor known as "Gridsteel", which holds the castable refractory linings in place longer and armors them against the bombardment of catalytic elements.

"Gridsteel" is available in a special loose clinch to conform easily to curved surfaces.

For complete information, write for brochure on Irving "Gridsteel" Contour Retainer Mesh

★

"A Fitting Grating for Every Purpose"

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IRVING SUBWAY GRATING CO., Inc.
Originators of the Grating Industry

Offices and Plants at
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AUTO-LITE

...for TEMPERATURE RECORDING...

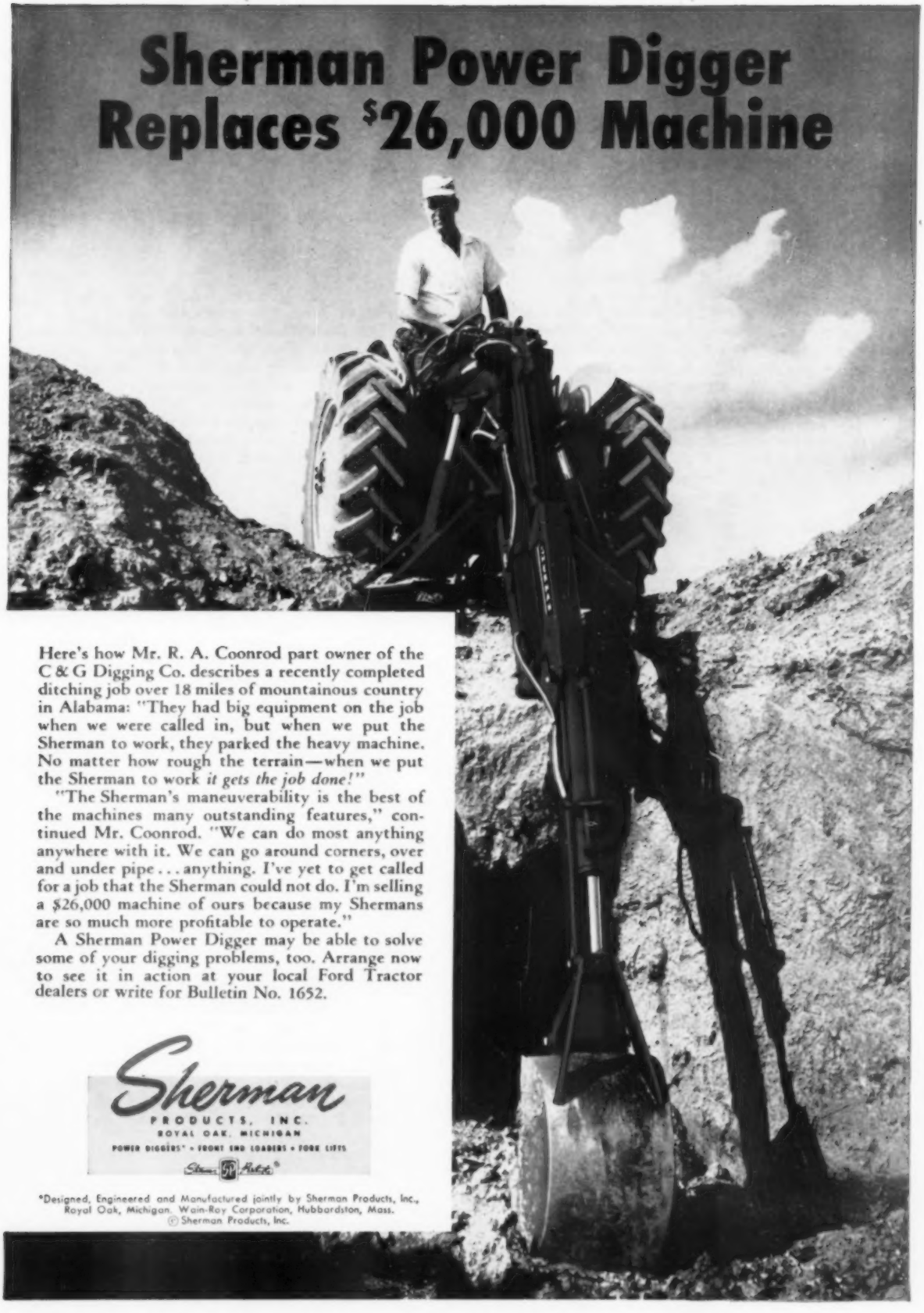
One of the many uses for Auto-Lite Recorders is the application shown below . . . a natural gas field meter run.

Auto-Lite Model "1000" Temperature Recorder has 6" chart. Various standard ranges from minus 40° F to plus 550° F. Available for wall mounting, portable or portable self contained use. Electric or mechanical chart drive. Choice of 24-hr. or 7-day cycle. Capillary tubing permits remote reading. Priced as low as $49.50. Manufactured to customers' specifications. Send for latest Catalog describing many types of Auto-Lite Recorders and Indicators.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE RECORDERS & INDICATORS

Sherman Power Digger Replaces $26,000 Machine



Here's how Mr. R. A. Coonrod part owner of the C & G Digging Co. describes a recently completed ditching job over 18 miles of mountainous country in Alabama: "They had big equipment on the job when we were called in, but when we put the Sherman to work, they parked the heavy machine. No matter how rough the terrain—when we put the Sherman to work *it gets the job done!*"

"The Sherman's maneuverability is the best of the machines many outstanding features," continued Mr. Coonrod. "We can do most anything anywhere with it. We can go around corners, over and under pipe . . . anything. I've yet to get called for a job that the Sherman could not do. I'm selling a $26,000 machine of ours because my Shermans are so much more profitable to operate."

A Sherman Power Digger may be able to solve some of your digging problems, too. Arrange now to see it in action at your local Ford Tractor dealers or write for Bulletin No. 1652.

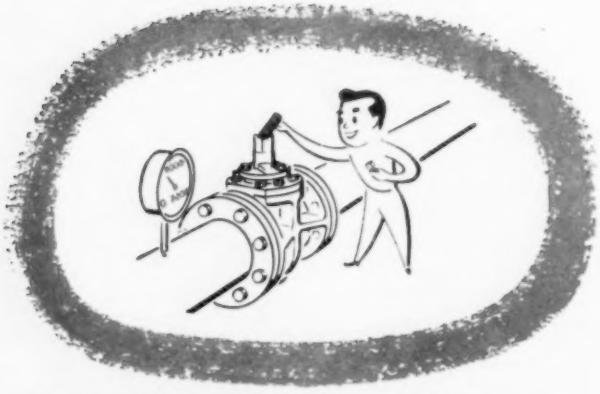
Sherman
PRODUCTS, INC.
ROYAL OAK, MICHIGAN
POWER DIGGERS* • FRONT END LOADERS • FORK LIFTS
Sherman Hi-Lift®

*Designed, Engineered and Manufactured jointly by Sherman Products, Inc., Royal Oak, Michigan. Wain-Roy Corporation, Hubbardston, Mass.
© Sherman Products, Inc.

WHAT IS THE ADVANTAGE OF A LUBRICATED VALVE?—The most important advantage of a lubricated valve is that it *seals far tighter* than ordinary valves. The thin film of plastic lubricant forced into the ports of the plug is a pressure seal in itself. And the possibility of seizing or galling is eliminated because the plug can be hydraulically jacked for instant operation Lubrication is also *preventive maintenance* against down time.

WHAT DOES THE LUBRICANT DO?—In a Rockwell-Nordstrom valve, lubricant is forced through grooves surrounding the plug ports where it acts as a *double seal* against leakage. By hydraulic action, lubricant under pressure also jacks up the plug keeping it free for *instant quarter-turn* operation. And lubrication means that operation is smooth and easy. Finally, lubricant prevents grinding wear for longer valve life at lowest cost.

DOES VALVE LUBRICATION ?



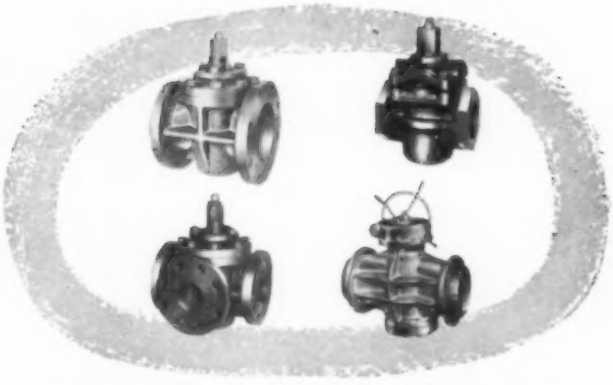
WHAT LUBRICANTS SHOULD BE USED?—Insist on genuine Rockwell lubricants—Rockwell is the largest and most experienced manufacturer of valve lubricants in the world. Rockwell lubricants are the result of years of field experience with nearly every process condition. For many services, there are variations of Rockwell lubricants compounded to offset specific line conditions. See your Rockwell sales engineer or write for Bulletin V-220 for complete details.

HOW LONG WILL PROPERLY LUBRICATED ROCKWELL-NORDSTROM VALVES LAST?—Many of the first Nordstrom valves put in service are still going strong. In gas distribution installations there are many valves with more than 30 years service. In a two-year paint plant study, Rockwell-Nordstrom valves were the only ones that did not need to be replaced because of leakage. Lubricant assures extra years of perfect service you can't expect from "dry" valves.

ROCKWELL

ROCKWELL-

LUBRICANT SEALED



WILL A ROCKWELL-NORDSTROM VALVE WORK WITHOUT LUBRICANT?—Yes, (even your automobile will function a short while without lubrication) but then the whole advantage of a lubricated valve is lost. Rockwell-Nordstrom lubricated plug valves are made to exceptional standards of tolerance and quality. However, it is their internal lubrication system which raises performance and economy standards far above any other type of valve.

HOW OFTEN SHOULD NORDSTROM VALVES BE LUBRICATED?—Basically, lubrication depends on service-temperature, process, frequency of operation, etc. Genuine Rockwell lubricants actually keep periodic lubrication to a minimum because they are specially compounded to handle specific services. Rockwell lubricant fittings of a button head type make the job fast, easy and every Rockwell-Nordstrom valve can be lubricated in service.

COST MONEY OR SAVE MONEY?

WHAT ABOUT MAINTENANCE COSTS?—Basically, lubrication is preventive maintenance against wear, replacement and down time costs. Also, lubrication—the key to leakproof, positive shut-off in Rockwell-Nordstrom valves—is an investment in safety and product loss or contamination. It's almost a mechanical axiom that *any* fully lubricated mechanism will require far less repair and parts replacement than a non-lubricated one.

YES, FOR 40 YEARS IT HAS BEEN PROVEN IN EVERY INDUSTRY THAT ROCKWELL–NORDSTROM LUBRICATED PLUG VALVES SAVE MAINTENANCE, REPAIR AND DOWN TIME DOLLARS. LUBRICATION IS AN INVESTMENT IN BETTER SERVICE, LONGER LIFE AND LOWER COST.*

**Note: First cost of Rockwell-Nordstrom valves is about the same—often lower—than ordinary valves.*

Rockwell-Nordstrom valves are available in semi-steel, steel, stainless and corrosion resisting metals and in a *full range* of sizes and pressures. For complete details on Rockwell-Nordstrom valves or Rockwell lubricants, see your supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

Nordstrom VALVES

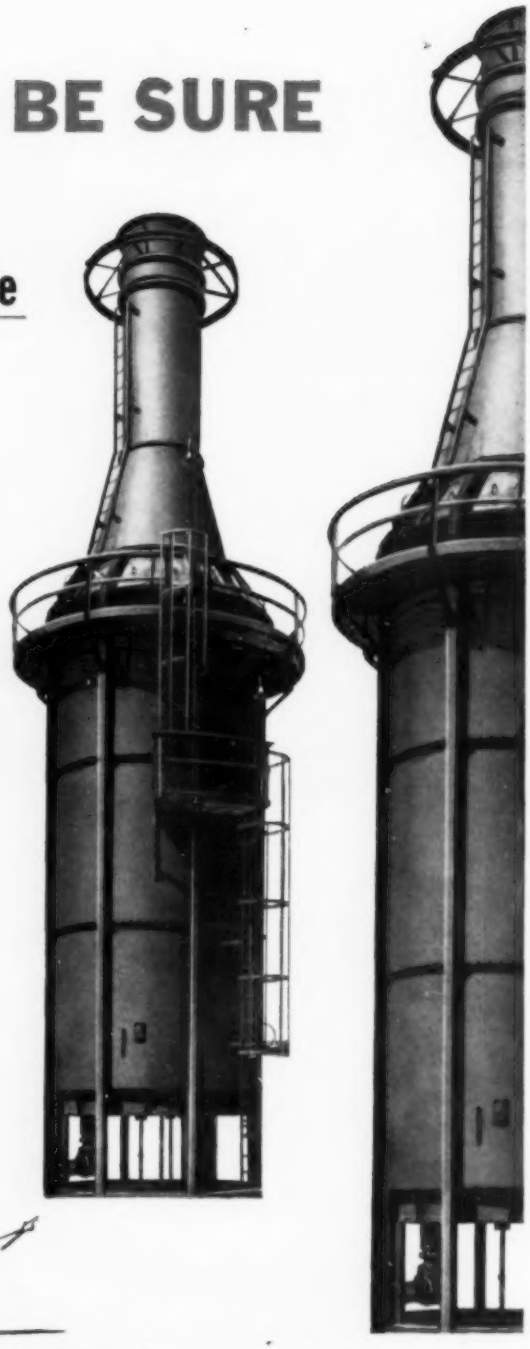
FOR POSITIVE SHUT-OFF

YOU, too, CAN BE SURE

petrochem-isoflow furnaces

are most economically desirable

by any comparison



Whenever *all* the specifications and *all* the operating requirements are applied to direct-fired furnace design, you can be sure PETROCHEM-ISOFLOW FURNACES will be found most economically desirable, by any comparison.

In making comparisons it is essential to take these factors into consideration:

1—Average radiant transfer rate.
2—Maximum deviation from average radiant transfer rate.
3—Average and maximum transfer rate in convection section.
4—Maximum tube wall temperature, radiant or convection.
5—Maximum efficiency with specified excess air.
6—Controlled thermal recirculation of flue gases to provide even heat distribution throughout full length of each tube and equalized heat distribution around each tube.
7—Overload and corresponding transfer load.
8—Design to provide: structural column supports—Ladders—Platforms—Tube Removal facilities, etc.
9—Degree of assembly; of the furnace structure and of the heating surface.

When you specify PETROCHEM-ISOFLOW FURNACES . . . you'll be in good company. More than 1500 are now in service, performing to the complete satisfaction of their operators and usually well beyond their rated capacities.

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

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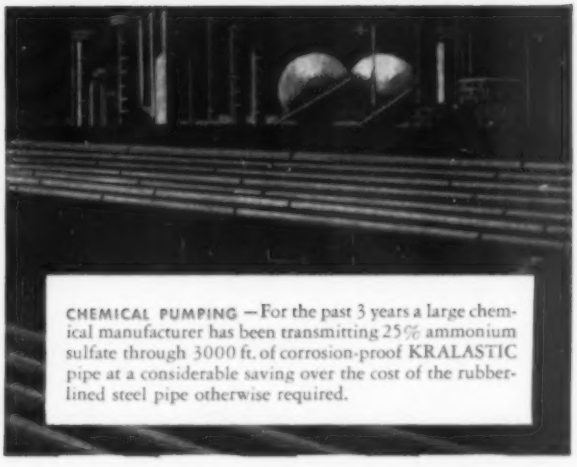
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE **READER SERVICE CARD**

KRALASTIC Corrosion-Proof Pipe Makes Good in Many Fields!

SALT WATER DISPOSAL—Operating under 20" to 28" of vacuum at 110°F. in a Texas oil field, a 4100 ft. stretch of 4" KRALASTIC pipe is still going strong after three years. A previous installation of pipe lasted only 6 weeks.

OIL FLOW LINES—Carrying very corrosive sour crude, a 1200 ft. section of 3" KRALASTIC pipe has performed satisfactorily for more than 4 years for a Texas oil company. Metal pipe previously used failed in only 4 months.

GAS LINES TO IRRIGATION PUMPS—In the Texas Panhandle a small crew recently laid 140 miles of KRALASTIC pipe 3 feet deep in 31 days. Texas farmers now have more than 1000 miles of KRALASTIC pipe carrying natural gas to irrigation pump engines.



CHEMICAL PUMPING—For the past 3 years a large chemical manufacturer has been transmitting 25% ammonium sulfate through 3000 ft. of corrosion-proof KRALASTIC pipe at a considerable saving over the cost of the rubber-lined steel pipe otherwise required.

KRALASTIC®, a unique combination of plastic and elastomeric materials, is different both in composition and physical properties from other materials used in the making of plastic pipe. It produces pipe—and many other plastic products—that are both hard and tough, low in weight, high in tensile strength and unaffected by most chemicals that corrode metals.

Pipe extruded of KRALASTIC has been approved by the National Sanitation Foundation for underground water transmission lines. Because of the inert nature of KRALASTIC, this pipe will not add taste or odor to drinking water and will not corrode and scale internally to cut down flow and pressure. For more information on KRALASTIC, write or phone us.

US RUBBER

United States Rubber

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BRANCHES: Akron • Boston • Gastonia, N.C. • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
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West Coast Transmission line.
Now under construction:

WILLIAMS BROTHERS ENGINEERS and CONSTRUCTORS

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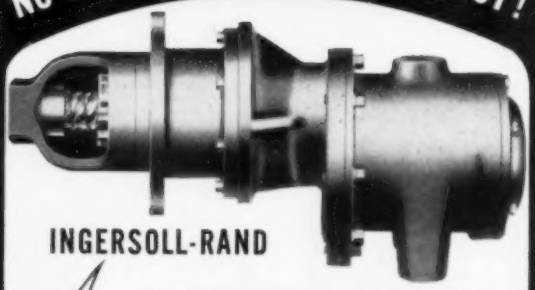
OIL • GAS • WATER PRODUCTS PIPELINES PUMPING STATIONS

NO BATTERIES TO WORRY ABOUT!



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Air STARTING MOTORS

give you trouble-free engine starts

RELIABLE—I-R Air Starting Motors are built for fast, sure engine starting—anywhere.

LOW COST—No batteries, generators or electrical parts to buy. Practically no maintenance expense.

COMPACT—I-R Air Starting Motors are lightweight, small but powerful. For all popular gasoline and diesel engine sizes. Easily installed.

Ask your engine distributor to show you the I-R Air Starting Motor line. Or write for Bulletin 5094A.

18-512

INGERSOLL-RAND
11 Broadway, New York 4, N.Y.

New! PATTON *oil seal puller*

SAVE TIME—
MONEY
PULLS OIL SEALS,
BEARING RACES
BRONZE BUSHINGS

The new PATTON Puller does the job quickly and easily without damage to parts and castings. In addition, oil seals, bearing races and dead-end bronze bushings are removed in a fraction of the time formerly required.

Originally designed for the Armed Forces, the PATTON Puller is now used in machine shops and maintenance and repair shops wherever machinery is repaired. PATTON Pullers save costly man hours and prevent unnecessary damage to component parts. Special sizes can be custom-made for specific requirements. Write for details.

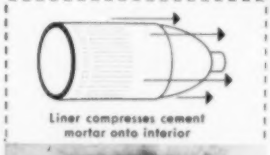
Certain areas are available for qualified distributors.

PATTON NO.	AIR FOR. STOCK NO.	HEAD SIZE
PM-8001 (Set)	7900-573278	Comp. Set 7/16" to 1 7/16"
PM-8051 (Set)	7900-573279	Comp. Set 1 17/32" to 4 1/16"
PM-8001-1 assy.	7900-573265-5	7/16" to 17/32"
PM-8001-2 assy.	7900-573265-75	9/16" to 25/32"
PM-8001-3 assy.	7900-573266	15/16" to 25/32"
PM-8001-4 assy.	7900-573266-25	25/32" to 1 1/16"
PM-8001-5 assy.	7900-573266-5	1 5/32" to 1 1/4"
PM-8001-6 assy.	7900-573266-75	1 11/32" to 1 7/16"
PM-8051-3 assy.	7900-573267-5	1 29/32" to 2"

Sizes from 3/4" to 4 1/2" available. Pat. No. 2380068 and Pat. Pend.

PATTON
MANUFACTURING COMPANY, INC.
1802 West Pleasant St., Springfield, Ohio

there's a better way to get it done!



Liner compresses cement mortar onto interior

Gives smooth, continuous, water proof lining of correct thickness

Tate Process applies cement mortar lining to the interior of 4" to 16" lines quickly and economically . . . while the lines stay "in place." Permanently restores full flow coefficients. Reduces pumping and maintenance costs. Protects against corrosion, contamination.

Write for full information TODAY!

Specializing in Pipe Protection Problems
• Tate and Centriline "In Place" Interior Cement Mortar Lining • "In Plant" and "Railhead" Centrifugal Spinning of Cement Mortar or Coal Tar Linings – Somastic® Exterior Coating • Pipe Wrapping • Reclamation: Removal of Old Wrapping, Straightening, Blasting, Beveling, Testing.

PIPE LININGS Inc.
2414 East 223 St. (P. O. Box 457)
Wilmington, California

NEW!

TUBE-TURN* "TAPER FACE" FLANGE

...cuts cost of light-duty piping

...protects low pressure pumps and valves

Tube Turns announces a new lightweight welding neck flange for service up to 125 lbs. W.O.G. pressure, offering two important cost-cutting advantages: (1) It is priced lower than conventional flanges. (2) This lightweight welding neck flange has a tapered face which affords an effective seal with reduced bolt loading; hence, permits use of steel butt welding neck flanges without danger of cracking the flat faced cast iron flanges of valves and pumps used in low pressure piping systems. Here is another result of Tube Turns pioneering research, and an example of how you get *more for your money* when you specify TUBE-TURN Welding Fittings and Flanges and buy them from your nearby Tube Turns' Distributor.

tt
TUBE-TURN

*"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

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HOW TO SAVE

How you cut costs with

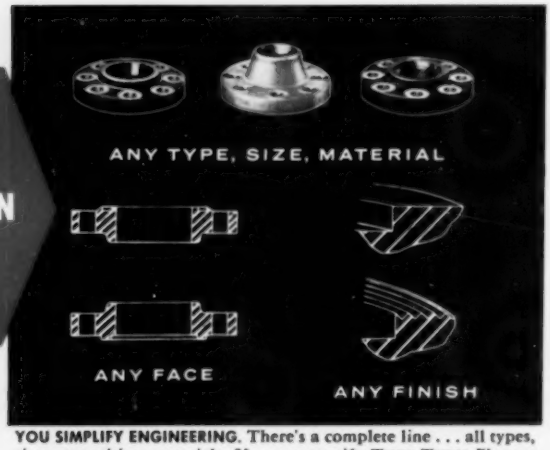
TUBE-TURN FLANGES

with the **NEW** Taper Face Flanges

CUTS FLANGE COSTS. For many applications of light-duty piping . . . up to 125 lb. W.O.G. pressure . . . the new TUBE-TURN Taper Face Flange gives rated performance at a lower price than conventional designs. Here's a good teammate for lightweight pipe and fittings in applications such as water, oil and gas distribution . . . on pumps and compressors . . . any installation where welded piping must be flanged to low pressure valves, pumps or equipment.

PROTECTS VALVES AND PUMPS. Lightweight and tapered face permit good seals with reduced bolt-loading on valve or pump flanges. Lighter, lower-priced valves can be used without danger of cracking their flat faced cast iron flanges. Also, lighter neck of flange speeds up welding to pipe.

with all **TUBE-TURN** Flanges



YOU SIMPLIFY ENGINEERING. There's a complete line . . . all types, sizes, capacities, materials. You can specify TUBE-TURN Flanges and know you'll get the exact answer to your problem. Also, Tube Turns offers you engineering help.

YOU STREAMLINE PURCHASING. Your nearby Tube Turns' Distributor provides complete-line service. This one source for all your needs in welding fittings and flanges enables you to put *all* your requirements on *one* order . . . to cut red tape, save valuable time.

MAIL FOR BOOKLET

The New line of Taper Face Flanges is described in this Tube Turns booklet . . . free on request.

TUBE TURNS, Dept. K-1
224 East Broadway, Louisville 1, Kentucky

Please send free Bulletin on Taper Face Flanges.

Company Name _____

Company Address _____

Your Name _____

Position _____

City _____ *Zone* _____ *State* _____

Available from your nearby TUBE TURNS' distributor

®"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

TUBE TURNS

LOUISVILLE 1, KENTUCKY

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

New York • Philadelphia • Pittsburgh • Cleveland • Detroit Chicago • Kansas City • Denver • Los Angeles • San Francisco Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

Right from the start . . .

FAST

POWERFUL

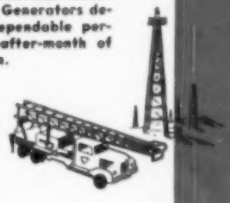
AMERICAN BOSCH MAGNETOS

Fast, powerful — that's the power-packed story of American Bosch Magnetos — today's finest ignition units for oil industry engines. Many advanced features give these famous Magnetos greater power for split-second starting, PLUS the built-in stamina that assures years of constant, trouble-free operation in Drilling, Producing, Pipe Line and Refinery service. That's why they're so widely used as original equipment by so many leading engine builders.

For your every replacement need, there's an American Bosch Magneto precisely engineered for maximum efficiency at all engine operating speeds and loads. Moreover, American Bosch can serve you well with all the advantages of one of the world's largest and most efficient Service organizations. There's an AB Service Agency near you. Write today for application data on your high or low tension ignition engines. American Bosch, Springfield 7, Mass. A Division of American Bosch Arma Corporation.

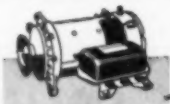
FOR OIL INDUSTRY HIGH & LOW TENSION SPARK IGNITED ENGINES

In drilling rigs, oil pumping stations, pipeline operations and gas-engine driven compressors . . . wherever they are in service in oil industry engines, American Bosch Magnetos and Pulse Generators deliver consistently dependable performance in month-after-month of continuous operation.



AMERICAN BOSCH

Automotive and Aviation Magnetos



Generators and Regulators

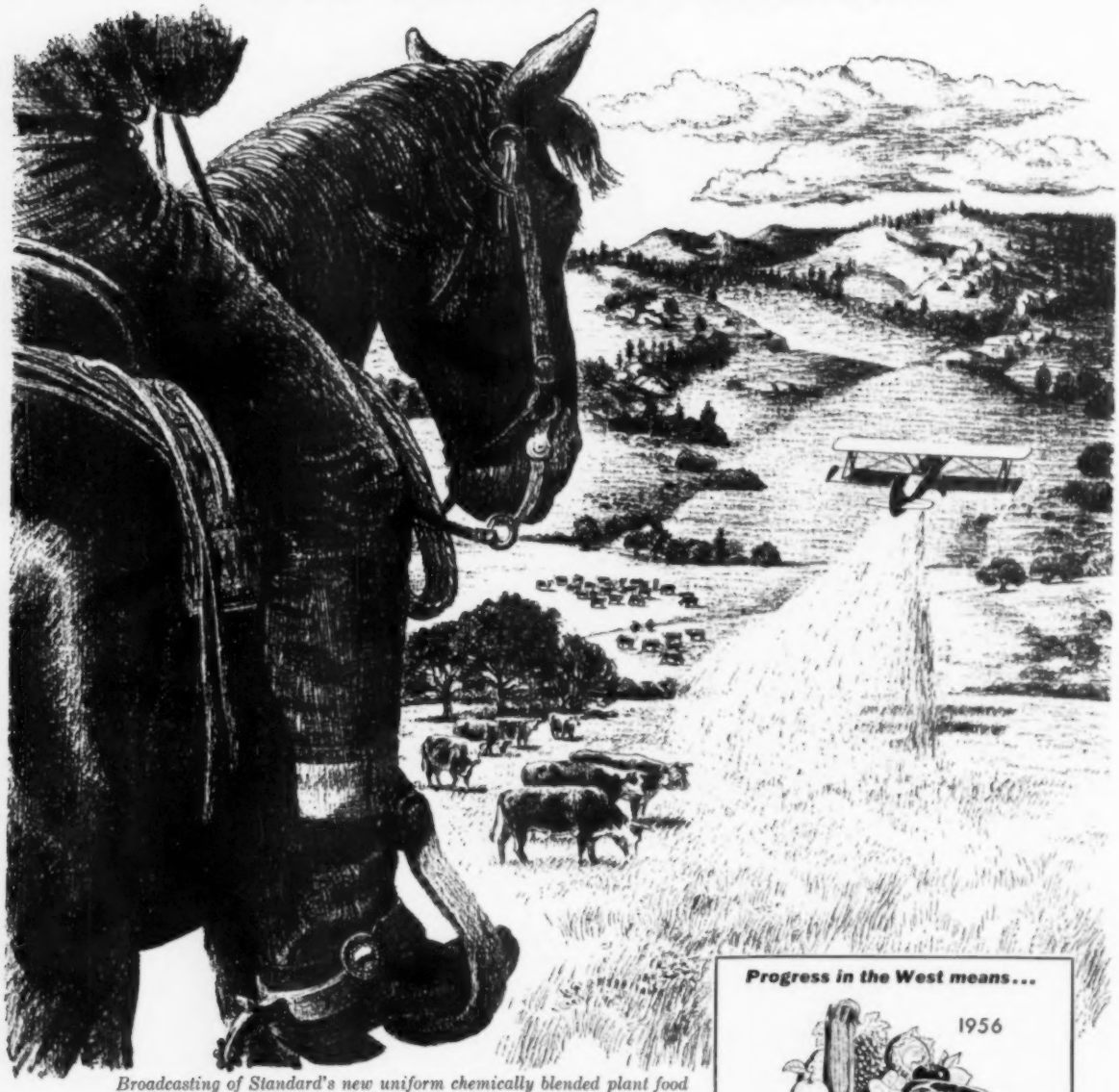
Components for Aircraft Engines

Small Electric Motors

Electric Windshield Wipers

Diesel Fuel Injection Equipment

New Standard plant foods help the West produce better meals at less cost



Broadcasting of Standard's new uniform chemically blended plant food by airplane can turn sparse hilly acres into rich pasture for livestock

RICHER SOIL means better crops, yet the West has never had enough soil-building fertilizer. To help meet farmers' needs, Standard opens a $16 million plant next month which will produce petroleum-derived plant food* in pellet form for Western soils and crops.

This uniform blend of essential plant growth elements is so effective that 400 pounds on an acre of grassland often enables it to feed 3 to 5 times more livestock. On other crops, too, it increases profits per acre. With this better use of Western land, your family will get tastier, more nourishing meals for every budget dollar.

Progress in the West means...

food production must increase 35% to feed the 26½ million people who'll live here by 1965

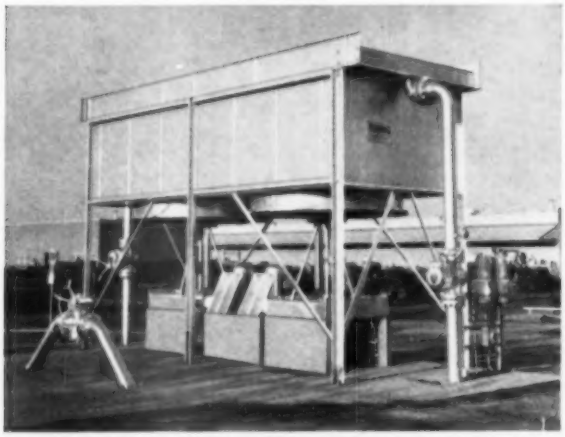
**One of many ORTHO PLANT FOODS, made and sold by Standard's wholly-owned subsidiary, California Spray-Chemical Corp.*

STANDARD OIL COMPANY OF CALIFORNIA

puts petroleum progress to work for you

Young Engineering Talent

Designs Efficient Gas Cooler For Pipeline Compressor Station



Young HC-1807 gas cooler designed for moderate operating pressure (500 psig operating pressure, 800 psig design pressure). Its V-belt drive turns two 81" fans.

HC" UNITS by Young

cool gas to proper temperature for pumping

At the Oklahoma City compressor station of the Oklahoma Natural Gas Company two "HC"—horizontal core—units made by Young Radiator Company are used to cool gas being fed through the pipeline. One of the units is shown above. A third Young-built "HC" cools engine jacket water, compressor jacket water, and lube oil cooling water for four 440 HP engine-compressors. The latter unit utilizes a single stream of water for all three services.

"HC" Heat Exchangers made by Young Lead in Efficiency, Economy and Versatility

These horizontal core units combine the *efficiency* of vertical air discharge, the *economy* of compact design, and the *versatility* of multiple unit combinations. They are especially practical for cooling water, oil and gases and for condensing steam and vapor.

Write Dept. B-217 for FREE Catalog.

Put Young Talent to work for you . . .

Solving heat transfer problems is what we do best because it is our very reason for being. You, too, can harness the power of Young engineering talent. Write, wire or call without obligation.

HC is a registered trademark.

Young RADIATOR COMPANY

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Creative HEAT TRANSFER ENGINEERS FOR INDUSTRY

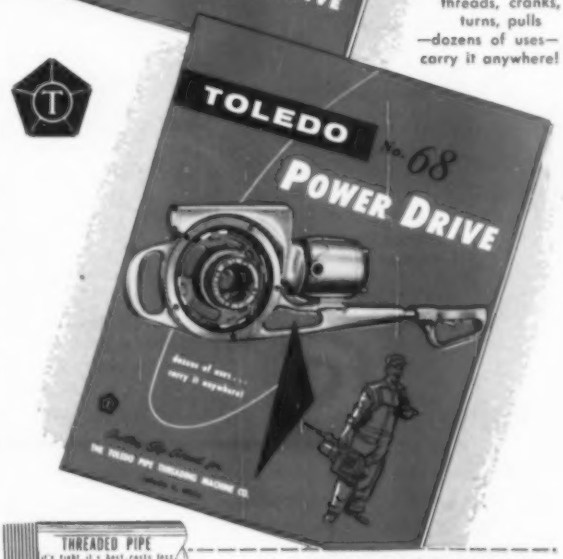
Heat Transfer Products for Automotive, Aviation and Industrial Applications. Heating, Cooling, Air Conditioning Products for Home and Industry.

Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

Get the Facts on TOLEDO PORTABLE POWER DRIVES

TOLEDO No. 78 Power Drive — with wrenchless chuck, forward or reverse rotation, ¼" to 2" capacity — a real work saver!

TOLEDO No. 68 Power Drive—threads, cranks, turns, pulls —dozens of uses—carry it anywhere!



THREADED PIPE it's right—it's best-costs less

Yes! Send me bulletins checked

THE TOLEDO PIPE THREADING MACHINE CO.
1445 Summit Street, Toledo 4, Ohio

☐ TOLEDO No. 78 Power Drive ☐ TOLEDO No. 68 Power Drive

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PIPE THREADERS • PIPE WRENCHES • PIPE MACHINES

THE TOLEDO PIPE THREADING MACHINE CO. • TOLEDO 4, OHIO

STATEMENT OF CONDITION

At the Close of Business December 31, 1956

ASSETS

Cash on Hand and Due from Banks		$338,382,415.31
United States Government Obligations	$118,629,268.26	
Public Housing Authority Obligations (Fully Guaranteed)	4,447,580.60	
State, County, and Municipal Bonds	18,184,286.86	141,261,135.72
Other Bonds		2,597,144.77
Stock in Federal Reserve Bank		1,500,000.00
Loans and Discounts		366,441,151.90
Income Accrued		2,456,648.10
Letters of Credit and Acceptances		19,787,457.42
Banking House and Equipment		9,588,236.89
Other Assets		130,513.96
		$882,144,704.07

LIABILITIES

Capital Stock	$ 22,000,000.00	
Surplus Fund	28,000,000.00	
Undivided Profits	4,675,017.24	$ 54,675,017.24
Reserved for Contingencies		7,368,504.40
Reserved for Taxes, Etc.		5,573,501.09
Deferred Income		1,552,267.33
Letters of Credit and Acceptances		19,787,457.42
DEPOSITS:		
Individual	481,810,804.97	
Banks	294,823,005.37	
U. S. Government	16,554,146.25	793,187,956.59
		$882,144,704.07

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between banks of today
is the way people are treated

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PRESIDENT

GIVE US AN OPPORTUNITY TO SERVE

81 years of growth through service to people

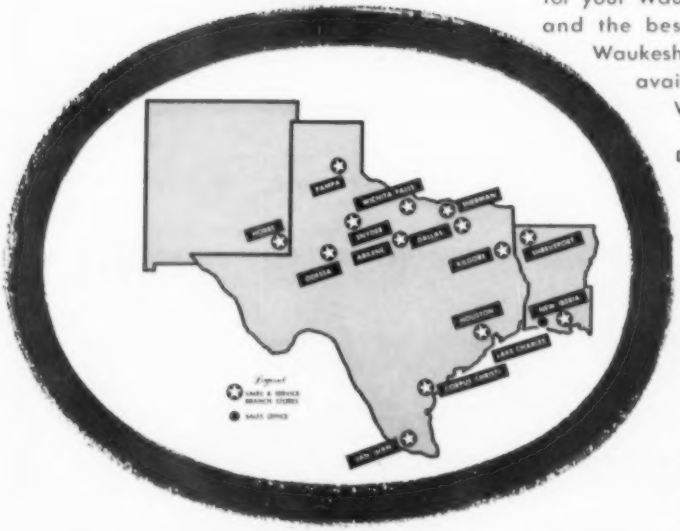
1st NATIONAL BANK in Dallas

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

DON'T FEED ME THAT FAKE STUFF

I WANT ONLY GENUINE WAUKESHA PARTS!

When you buy a Waukesha engine you buy the finest power equipment money can buy. When you need parts for your Waukesha engine you naturally want the best—and the best parts, the parts made specifically for Waukesha engines, are **genuine** Waukesha parts, available throughout the oil country through Waukesha Sales and Service, Inc. stores.



Don't take a chance. Buy genuine Waukesha parts from the Waukesha Sales and Service, Inc. store near you.

WAUKESHA

Sales & Service, Inc.

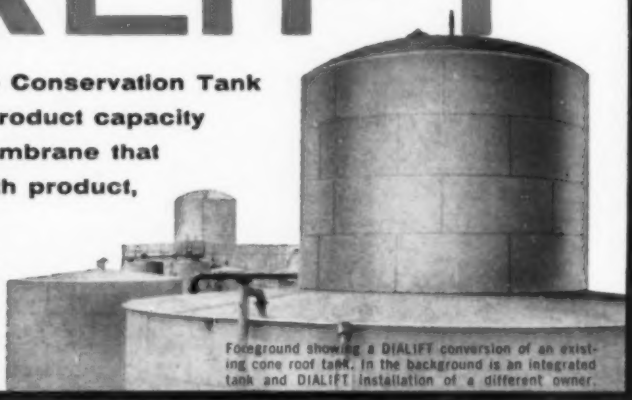
1422 MAURY ST. • HOUSTON, TEXAS

EXCLUSIVE DISTRIBUTORS FOR WAUKESHA PRODUCTS IN TEXAS, NORTH AND WESTERN LOUISIANA, SOUTHERN ARKANSAS AND NEW MEXICO

WORLD'S LARGEST DISTRIBUTOR OF OIL FIELD ENGINES

The HAMMOND
DIALIFT

The ONLY membrane type Conservation Tank with full-rated vapor and product capacity AT ALL TIMES, with a membrane that cannot come in contact with product, vapor space that can be isolated for inspection and maintenance without taking product storage tank out of service.



Foreground showing a DIALIFT conversion of an existing cone roof tank. In the background is an integrated tank and DIALIFT installation of a different owner.

Principle of the Hammond Dialift

A— DIALIFT DIAPHRAGM rises and falls to accommodate expanding and contracting vapor.
B— Vapor passes to and from tank and DIALIFT through simple elbow connection.
C— DIALIFT and tank have full-rated capacity.
D— Membrane can't come in contact with product.
E— DIALIFT can be isolated for maintenance and inspection, product tank stays in service.

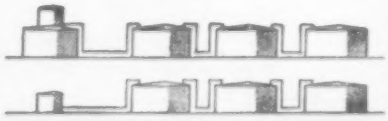
The most efficient and economical vapor conservation system for new or old tanks.

THE HAMMOND DIALIFT consists of a gas-tight Vulcalock membrane attached to the inside periphery of a cylindrical metal housing to become a "breathing" apparatus to accommodate the expanding and contracting vapor as developed in product storage tanks. The DIALIFT can be used as a single conservation unit by being attached to the roof of a product storage tank or as a central "breathing" system by being manifolded to a number of product storage tanks. There are two forms of installation: —Ground type manifolded to a number of tanks to form a conservation system and integrated type whereby the DIALIFT is attached to the roof of a product tank for vapor conservation for one or a number of tanks.

The DIALIFT is completely isolated from the product storage tank. Vapor passes between the tank and DIALIFT through a vaporline connection. It is easy to convert old cone roof tanks to efficient vapor-saving DIALIFT installations by attaching a DIALIFT housing with membrane to the roof of the old tank and connecting the vaporline between the tank and DIALIFT.

New or converted DIALIFT tank, inter-connected with cone-roof tanks, becomes central "breathing" unit.

DIALIFT GROUND UNIT serves as central "breathing" apparatus of multi-tank conservation system.



The HAMMOND dialift eliminates breathing loss and reduces filling loss

Other HAMMOND Bulletins describe these individual types of tanks: Floating Roof, Diaflote,* Vaporlift, Field Erected Unaerground, Elevated Water Tanks and Standpipes, Low Pressure, Bulk Storage.

Write for Dialift Catalog 55DL

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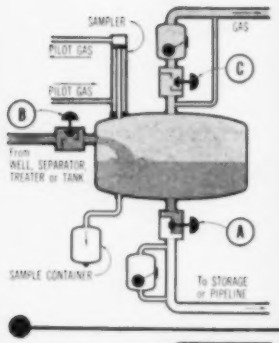
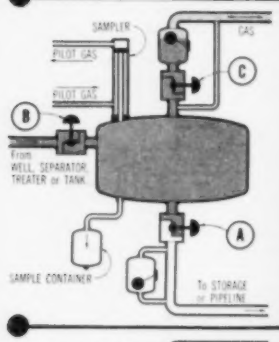
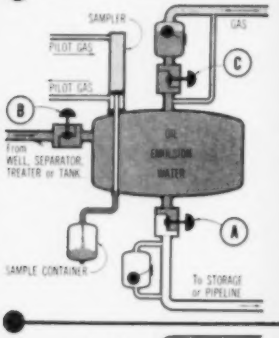
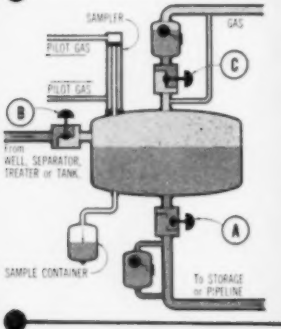
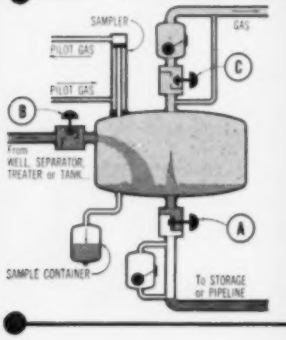
Salary open. Liberal company benefits. Send complete resume outlining experience and salary requisite to Box PE261, 125 West 41 st., New York City.











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WITH CORE BARREL SAMPLER

Patent applied for

FOR POSITIVE MEASUREMENT OF LIQUID FROM WELL, SEPARATOR, TREATER OR TANK

The PVM* meter is liquid packed, sampled, and then counted as the liquid is discharged. Its accuracy is indisputable as to volume of liquid measured at the pressure-temperature condition of operation.

A very unique feature is the automatic sampling of each cycle which takes out a core and saves it in a separate container attached so that exact content of BS&W can be determined later.

The PVM may be calibrated for an exact volume with compensation made for a given oil composition, temperature, and pressure.

The PVM Meter with Sampler is the most important development in oil field liquid metering yet offered.

The Core Barrel Sampler* used in conjunction with the PVM completes the requirements for metering oil field liquids. The Sampler cuts a core vertically through the liquid and deposits same in a container. Thus an exact and representative core is taken from a fixed volume. The composite sample when analyzed will give the true percentage of oil, water and/or emulsion that has been metered.

**PVM and Core Barrel Sampler are the trademarks of National Tank Company*

- **FILLING** — Valve **A** is closed to retain liquid in metering chamber. Valve **B** is open to admit liquid and Valve **C** is open. The Sample Barrel is up out of the stream.
- **POSITIVE VOLUME ISOLATION** — Valve **A** is still closed; meter fills past Valve **C** which closes. Valve **B** closes, assuring meter to be full of liquid. Note the volume trapped by Valves **A**, **B** and **C** is positive and not affected by float control levels.
- **CORE BARREL SAMPLING OF LIQUID** — Valves **A**, **B** and **C** are closed. Sample tube is driven vertically through the liquid, assuring a representative, proportional sample of the entire content as it exists in the vessel. Sample is discharged to a container for future analysis. Sampler is retracted.
- **DISCHARGING AND RECORDING** — Valve **A** now opens permitting vessel to empty the positive volume. The cycle counter is actuated. Valves **B** and **C** are still closed.
- **VALVES REPOSITION** — Valve **A** closes; Valve **C** is opened, dropping fluid into meter for measurement with next volume and Valve **B** opens for new cycle.

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NATIONAL TANK COMPANY

TULSA, OKLAHOMA

IT'S BRAND NEW!

The O-C-T UNIVERSAL TUBING HEAD

. . with 6 interchangeable dual string and single string tubing hangers!

The new O-C-T universal tubing head is available with a complete range of interchangeable tubing hangers for both dual and single strings. Last minute changes in completions can be made without changing tubing heads or using special attachments. If only one producing sand is found in a proposed dual well, the well may be completed by using a single string hanger. If a second sand is found in a well originally scheduled for single completion, the well may be completed with a dual hanger instead of the single hanger originally contemplated.

The O-C-T universal tubing head is equipped with two retractable aligning screws which are used to align the dual hanger with respect to the head itself. These aligning screws are retracted when single string hangers are used.

Safety is assured, since all hangers are run through, landed and locked in place prior to the removal of blowout preventers. Once the head has been installed, all seals can be field tested through test ports located in the flanges.

This universal head is available in 600 through 2900 series and flange sizes from 6" to 10". If an operator does not desire to remove the existing tubing head in order to dually complete a well, an adapter is available.

Any of six interchangeable hangers may be landed and locked in place through blowout preventers

All seals may be tested by a single application of pressure through a test port in the top adapter flange

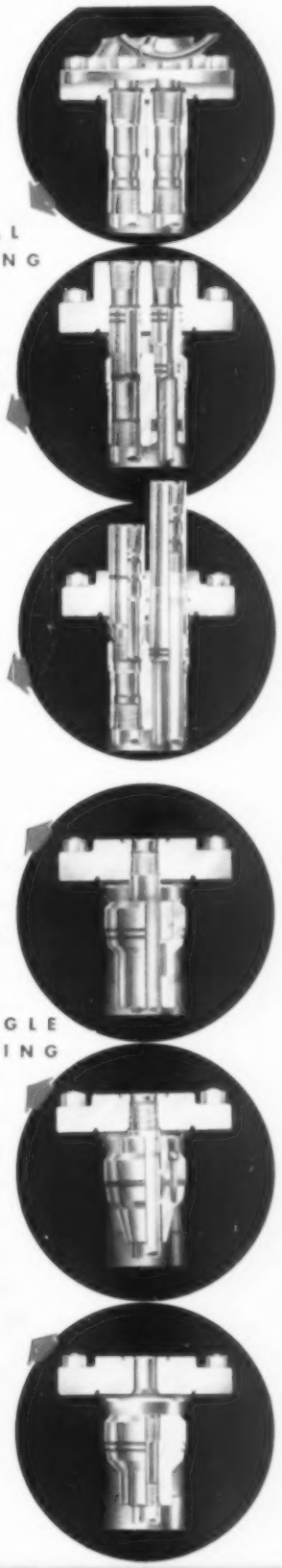
O·C·T

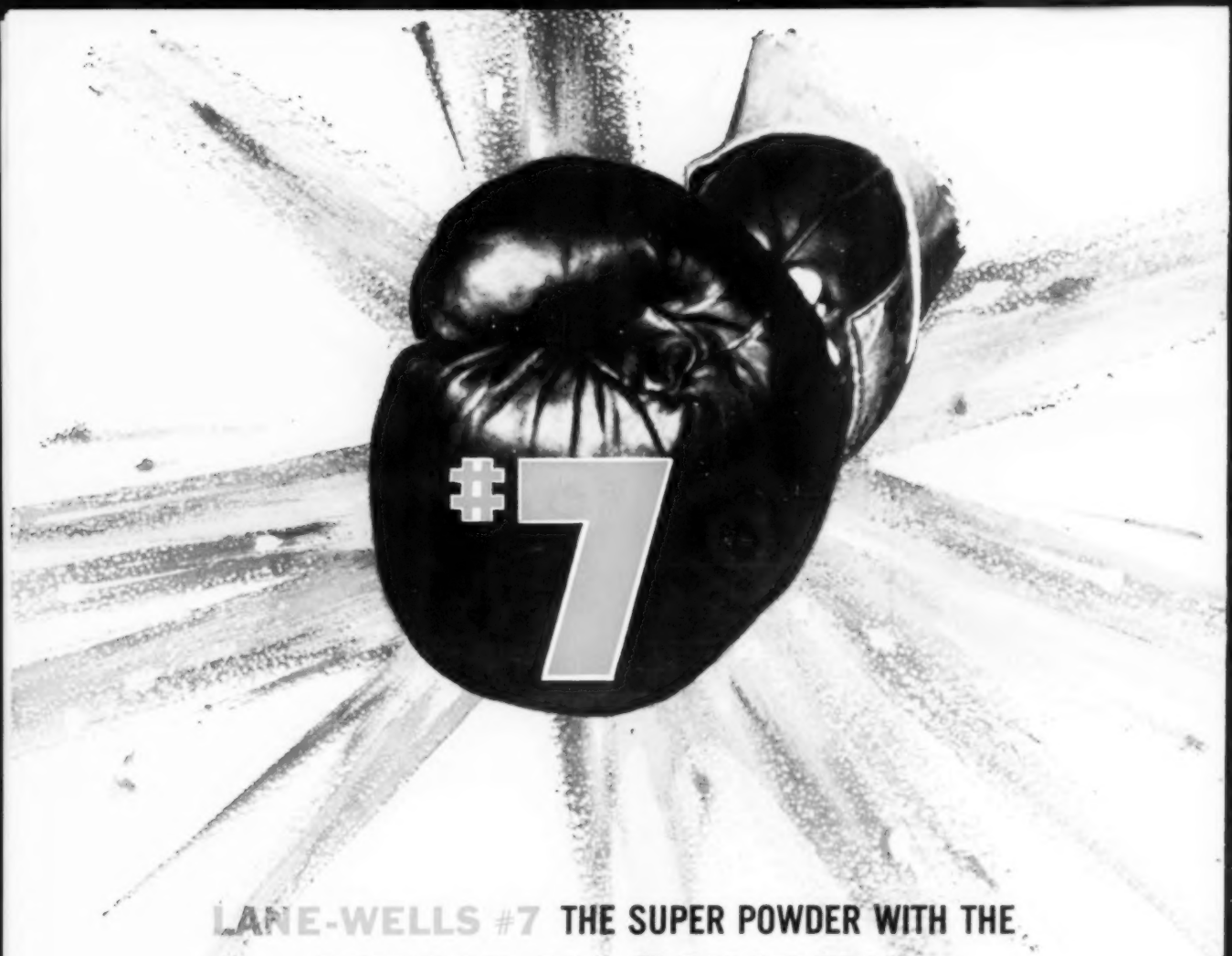
OIL CENTER TOOL CO.

Export Representatives: South America — East West Oiltools, C. A., Del Lago Hotel, Maracaibo, Venezuela. Address Export Inquiries for All Other Countries to P. O. Box 3091, Houston, Texas.

DUAL STRING

SINGLE STRING





LANE-WELLS #7 THE SUPER POWDER WITH THE "SUNDAY PUNCH!"

Gives additional penetration to Lane-Wells guns—at no added cost to you.

Welcome a strong new member of Lane-Wells' service arsenal...#7 Powder. Tests prove additional inches, deeper into the formation, are added to penetration you now get.

And not just our tests show this deeper penetration. See what happened when a major oil company ran their own tests. They set up duplicate targets, identical except that the tensile strength of the cement in one was 450 psi and 558 psi in the other. Tougher targets were for #7 Powder...but for all that, bullets driven into these targets by #7 Powder penetrated 8.30" to the point of the bullet as compared to 6.22" of penetration gained by bullets fired into the easier targets.

There's no price premium for this powerful new powder either—it's just added to other steady improvements in Lane-Wells service.

Tomorrow's Tools—Today!

Ask your Lane-Wells man about #7 Powder for your perforating job—and remember you get the best in service when you call

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Of Things To Come . . . . . In Oil

LOUISIANA WILL BE NO. 2 OIL PRODUCING STATE in 1957 to replace California. The Pelican state already is crowding California because of Gulf Coast crude demands brought on by the Middle East situation. Two recent allowable increases put Louisiana flow at 973,000 bbl daily —slightly above the California production of about 950,000 bbl daily.

U. S. DRILLING IN 1957 will set even more well and footage records than in 1956 (58,200 wells, 235,000,000 ft of hole), says Jack Abernathy, president of the American Association of Oilwell Drilling Contractors. Unless imports are cut back, says Abernathy, there will be only a 1 percent increase in drilling and production capital spending, "resulting in a reduction in average number of rigs operating." Due to Southwestern crude price increases, these figures may be revised upward.

OIL'S FIRST DILEMMA OF THE YEAR is that of production allocation to meet the government's commitments to bolster Europe's oil shortage. Independents who have championed more production now are shying away from the idea feeling that they'd be losing money at current crude prices. Gasoline stocks are high, and refiners want to ship motor fuels in lieu of crude. It's likely that allowables will be increased in months to come to meet the 600-800,000 bbl/day oil shipments to Europe. However, it will probably be "across the board" rather than area-wise.

1100 PERCENT MORE EXTRA-DEEP WELLS (18,000 ft +) will be drilled in 1965, as compared to the seven drilled in 1956, figures the Humble exploration department and attested by Humble Vice President and Director C. E. Reistle, Jr. He predicts that in California and the Gulf Coast area, some 82 extra deep wells will be drilled in 1965, also that 332 wells 16,000 ft and deeper will be drilled in that year, compared to the 47 drilled in 1956—a 600 percent increase.

ARGENTINE OIL WILL BE GOVERNMENT DEVELOPED—without private concessions, new declarations indicate. Government has issued a statement with an order to the nation's Central Bank to turn over $11,000,000 in foreign exchange to buy needed oil equipment and expand production. This most recent communique from Argentina crossed out remarks by President Aramburu late in December, 1956, indicating a possible departure from the government oil monopoly policy.

NAVAJO INDIANS WILL GET 50-50 PROFIT SHARING PLAN on their oil and gas lands. Tribal leaders are now conferring with government officials to work out further details similar to the Delhi-Taylor plan rejected in 1956, labeled as "non-competitive." Officials are studying contracts between American oil companies and Venezuela for possible pattern for new Indian leasing in the western states.

why 100% WAUKESHA

Harry J. Schafer
President
SCHAFER DRILLING CO.
can tell you

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Liberty Bank Building
OKLAHOMA CITY, OKLAHOMA
Tel. REgent 9-1607

Harry J. Schafer, President

November 1, 1956

Waukesha Motor Company
Waukesha, Wisconsin

Gentlemen:

In my many years as an Oil Producer, I have used almost all makes and types of applicable engines on my wells that were "on the pump." Through the years Waukesha engines have done the most all around satisfactory job for me. I also noticed that the large majority of drilling contractors, drilling wells for me, had Waukesha engines on their drilling rigs.

Therefore, in 1952 when I decided to form my own drilling company, naturally I equipped my first rigs with Waukesha engines. Due to their excellent performance and economy of operation, I have had all of my rigs similarly equipped.

I am proud to say that we are a 100 per cent Waukesha customer. My congratulations on a truly fine product.

Very truly yours,

Harry J. Schafer

HJS:ah

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Engines and Power Units up to 1135 hp

LP Gas • Natural Gas
Normal and
Turbocharged Diesels

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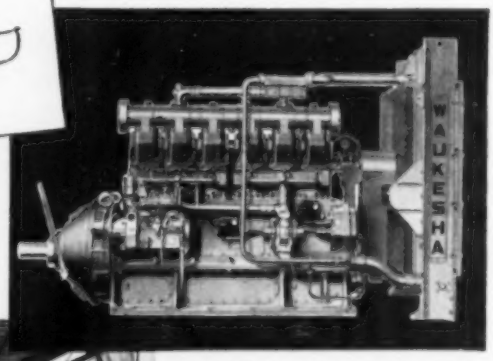
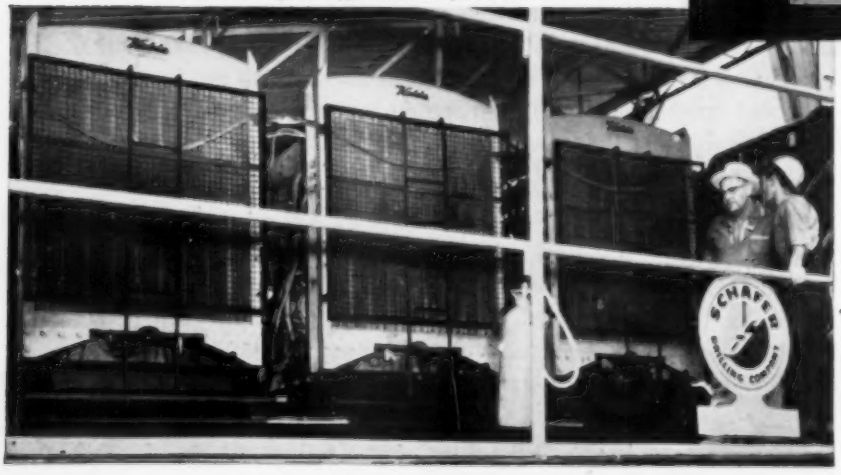


Schafer Rig No. 5, drilling at 8,111 ft., Cook No. 2 well, Cement, Okla. This rig, a Unit U-40, has two pumps. Toolpusher Jack (R. J.) Hinchey and Jim Saylor, daylight driller, look pleased with its 3 Waukesha LROU gas power units. Schafer Drilling Co. has seven rigs *100% Waukesha-powered.*



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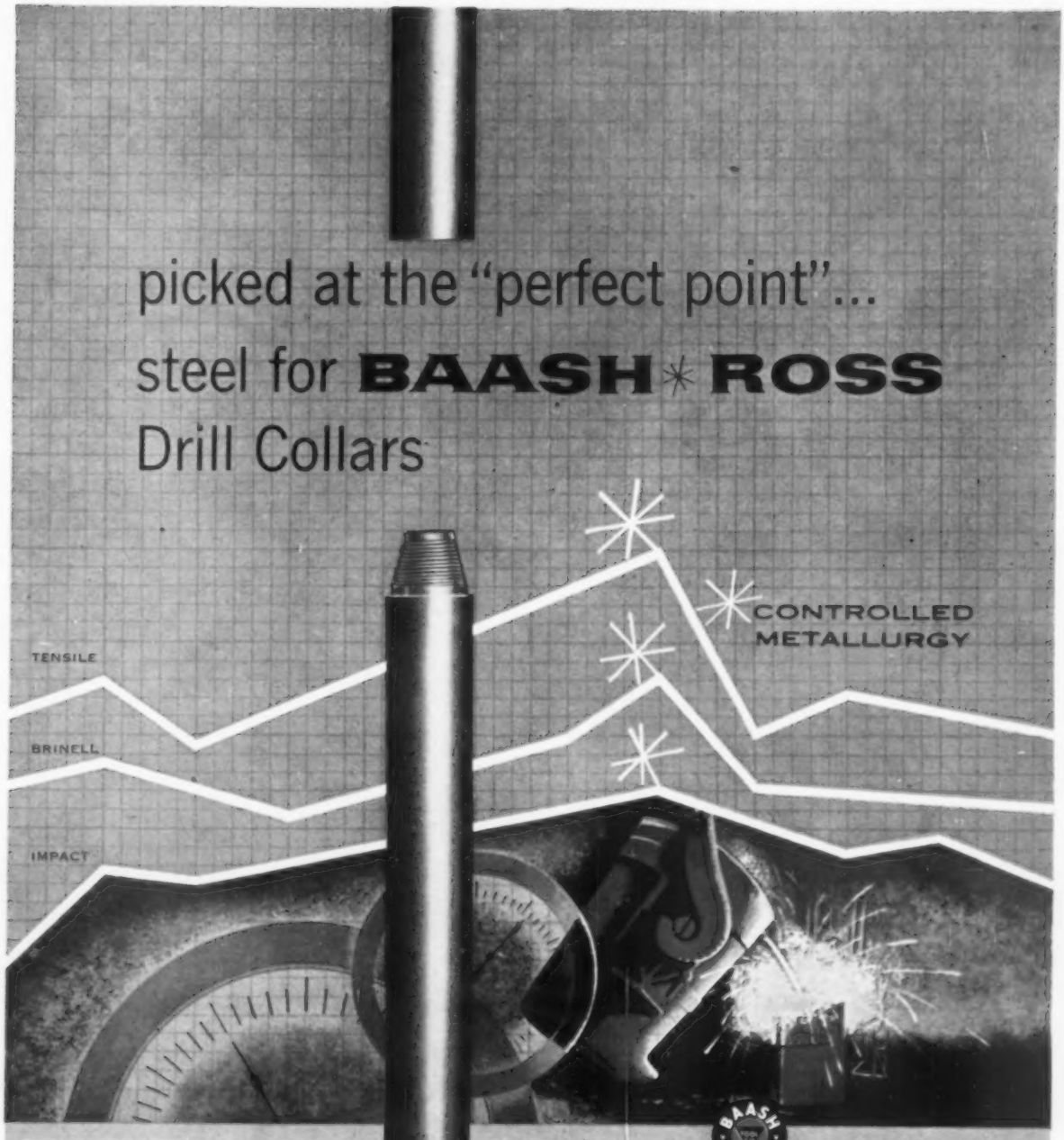
picked at the "perfect point"... steel for BAASH * ROSS Drill Collars



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DRILL COLLARS

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CONTROLLED HEAT TREAT produces stress free homogenous structure with the desired physical properties.

PRECISE MACHINING – API specifications exceeded.

RIGID INSPECTION during every phase of manufacturing.

LONGER WEAR means less cost per foot.

For further information write P. O. Box 1348, Houston 1, Texas or see The Composite Catalog.

BAASH-ROSS

Baash-Ross Drill Collars are the top choice because specialized manufacturing techniques have been developed and perfected which are unsurpassed in the industry. Buy the best – in drilling and production tools – buy Baash-Ross.

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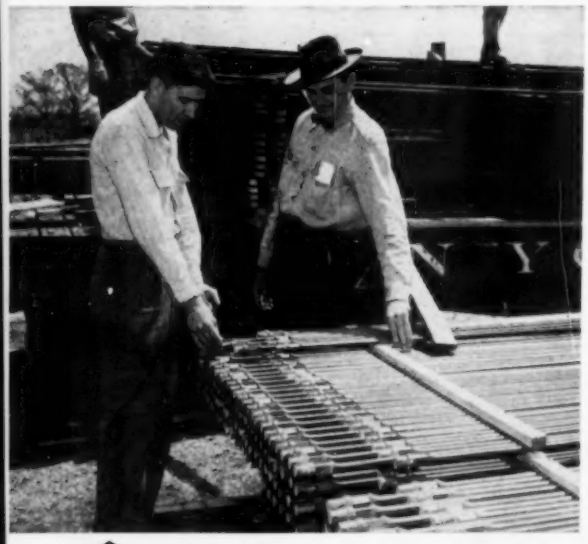
AXELSON PICTORIAL

OPEN HOUSE. At the opening of new district offices for Continental Oil Company at Eunice, New Mexico, this was the reception committee: (left to right) Ruth Carter, Bob Gault, Janelle Johnson, Patsy Marshall, Joe Habelman, Donnie Niales, Hal Cox, and George Cummings. Conoco now has two district offices in New Mexico; the other is at Hobbs.



35,000 FEET. Unloading a carload of Axelson Sucker Rods at the J&L store in Shreveport, Louisiana, are C. F. Haman (right), Store Manager, and W. L. Holloway, Pelican Trucking Company. The shipment weighed 23 tons and consisted of 35,000 feet of #59 and #60 pin and pin rods in $\frac{5}{8}$" and $\frac{3}{4}$" sizes, about a two-month supply.

FREELOADER. This was the coffee and sandwich bar at Continental Oil Company's Open House in the new district offices at Eunice, New Mexico. Conoco's charming secretaries serve the boss, W. E. Allen, Superintendent of the newly opened Eunice district. Hostesses are Patsy Marshall, Donnie Niales, Janelle Johnson, Ruth Carter.

WHAT'LL YOU HAVE? Buying pump parts for Alice Johnson #4 in the Muenster Field, Cook County, Texas, is F. E. Heath (right), District Foreman for General American Oil Company of Texas. An Axelson Plunger Pump was installed in this well in 1944 and is still pumping. Because of a severe corrosive condition, it is pulled every three months, reworked and rerun into the well. D. C. Jones, J&L Manager of the Muenster store, writes up the order.

A landlubber goes to sea

BOOM. This well (Mrs. Jessie Brown et al No. 1) was the discovery well for the Kelley-Snyder Field in Scurry County, West Texas, for Standard Oil Company of Texas. Completed November 1948, it was responsible for the great Snyder boom of 1949-50. It is now a water-injection well for the SACROC unit, the largest utilized operation in the world. Many Axelson 2" ($1\frac{1}{2}$") Sure-Seal and 2" ($1\frac{1}{4}$") RL Pumps are at work in this field. (Left to right) Bob Hand, District Engineer; Norman Phillips, Production Foreman; George Ator, Production Clerk, all of Standard of Texas, and Forrest Goin, Axelson Representative.

SINCE '24. Looking over the Mitchell #1 in the Wellington Field at Fort Collins, Colorado, are Emmet Richman (right), Production Foreman, Fort Collins Producing Company, and Tom Mayo, Axelson District Manager. The 4,200 ft. well makes 220 B/D (10 bbls. net of 35 gravity oil) with an Axelson $2\frac{1}{2}$ x 2 x 12 RWT Sure-Seal – the ideal pump for water flooded wells. Richman has been using Axelson equipment since 1924.

No. 9

AXELSON

AXELSON MANUFACTURING COMPANY

Division of U. S. Industries, Inc.

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Specify **AXELSON** *for*
Subsurface Pumps
Sucker Rods
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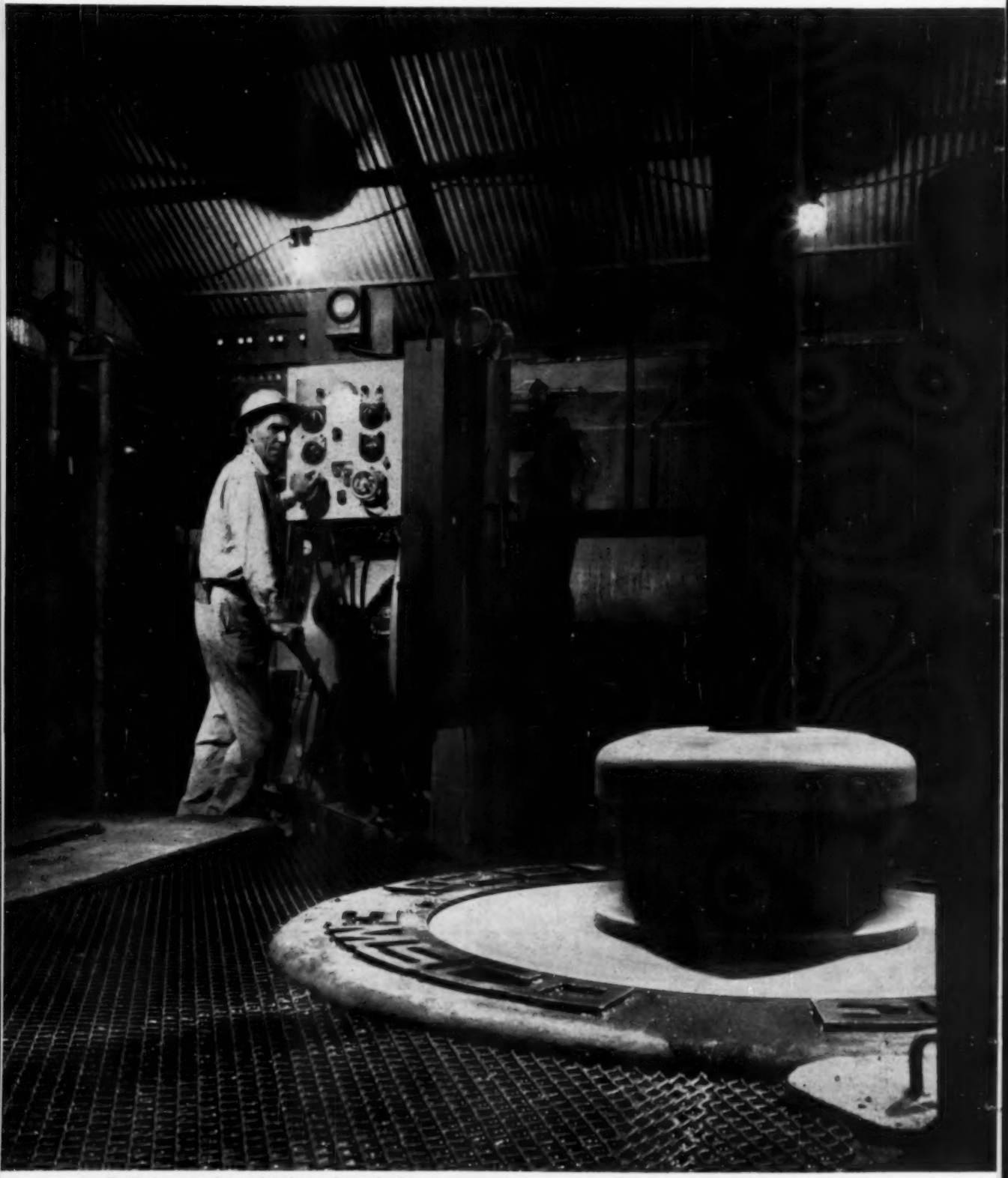
CALIFORNIA: *Axelson stores at Bakersfield, Coalinga, Huntington Beach, Long Beach, Orcutt, Santa Fe Springs, Taft, Ventura; Hickey Pipe & Supply Co. (Sucker Rods)* • **MID-CONTINENT**: *Jones & Laughlin Steel Corporation, Supply Division (Headquarters, Tulsa)* **ROCKY MOUNTAINS**: *Jones & Laughlin Steel Corporation, Supply Division; Great Northern Tool & Supply Co., Billings, Montana* • **CANADA**: *Jones & Laughlin Steel Sales Co. Ltd., Calgary; Dominion Oilfield Supply Co. Ltd., Calgary* • **MEXICO, D. F.**: *Wells Fargo & Co. Express, S. A.* • **RIO DE JANEIRO, BRAZIL**: *MAQUIP (Commercial de Maquinas e Equipamentos) S. A.* • **LIMA, PERU**: *Gross Equipment, S. A.* • **LA PAZ, BOLIVIA**: *Del Prado & Compania, Ltd.* • **BUENOS AIRES, ARGENTINA**: *Adrian Bolland & Cia., S. R. L.* • **BARCELONA, VENEZUELA**: *Servicios Industriales, C. A.* • **MARACAIBO, VENEZUELA**: *Servicios Industriales, C. A.* • **BOGOTA, COLOMBIA**: *Servicios Industriales, C. A.* • **TRINIDAD, B. W. I.**: *Industrial Agencies, Ltd.*

BIG CHIEF USES

A landlubber goes to sea . . .



Driller's control stand is located beside draw works and just behind rotary table. From this point the driller can oversee every operation. From one panel he has complete control of all Diesel-electric equipment.

. . BIG CHIEF USES ELECTRO-MOTIVE POWER on first offshore rig

Big Chief Drilling Company of Oklahoma City was a landlubber for twenty years before plunging into offshore drilling. More than a year was spent studying offshore problems, designing equipment before launching Rig 34. Why they picked Electro-Motive Diesel-Electric Power is told here:

Deck cost cut to minimum

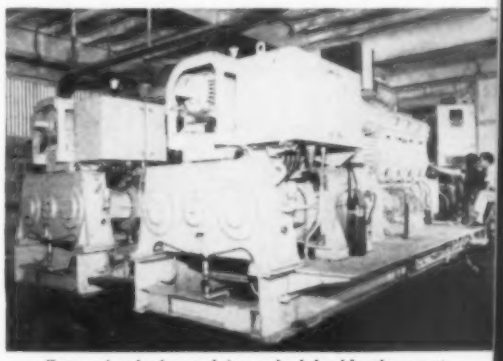
Platform deck area measures only 88 by 145 feet. Living quarters, fuel storage, mud, water, pipe racks, etc., alone take 88 by 110 feet. In the space left, (35x88) Big Chief's engineers had to pack a complete rig and provide for location of six wells. Solution: Electro-Motive Power with flexible cables permitted locating components in a space-saving three story design.

Big power, simple control

Two 900-hp GM Diesel engines driving four 500-kw dc generators supply power to 625-hp drive motors on mud pumps, rotary and draw works. Coupled with this power is a simple and accurate control system that provides smooth and rapid acceleration of loads with positive control of speed and torque. Result: flexible control for faster, lower cost drilling.

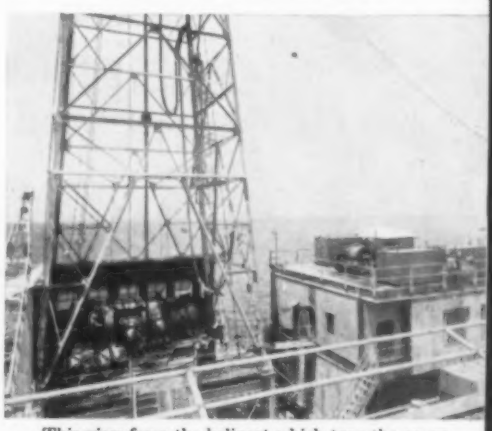
Matched components

Electro-Motive Power is a complete drilling power system. Each component was designed and built to work together—one manufacturer—one source of responsibility. The tested dependability and widespread acceptance of this power is proof of its drilling advantages on land or water. For your convenience there's an Electro-Motive Representative located in every major drilling area.



Conveniently located in a shed beside the mast are the two 975-hp generating sets. Each drives two 500-kw dc generators and comes complete on skids with controls and cooling system. Note how cables to drive motors are neatly routed on overhead trays.

Two 625-hp dc drive motors supply power for draw works. Generators are connected to these motors through electric cables, permitting complete flexibility of arrangement. In fact, the entire Diesel-electric system can readily be adapted to any platform.

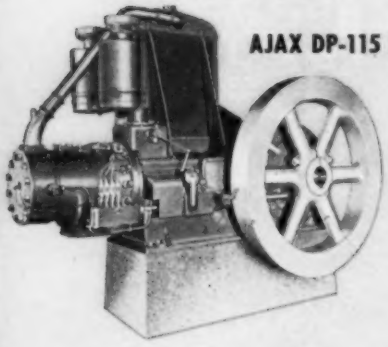


This view from the heliport which tops the crews quarters shows the simple and efficient layout of Rig 34. At left is the driller's stand, at right the engine generator shed. Below deck are pumps and tanks for mud, fuel and water.

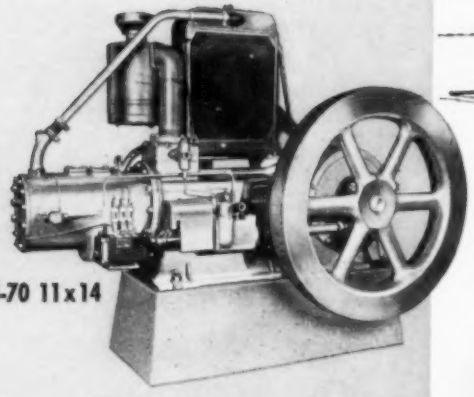
ELECTRO-MOTIVE DIVISION
GENERAL MOTORS LA GRANGE, ILLINOIS

In Canada: General Motors Diesel Limited, London, Ontario

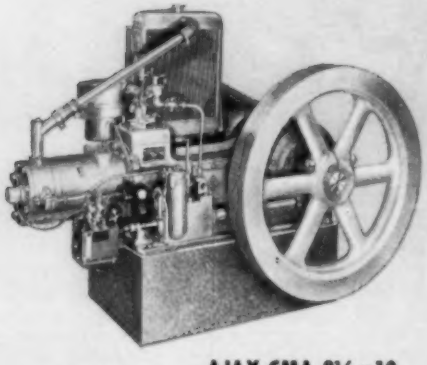
Petroleum industry sales offices: Tulsa, Oklahoma; Houston, Texas; Dallas, Texas; Morgan City, Louisiana; Pasadena, California.



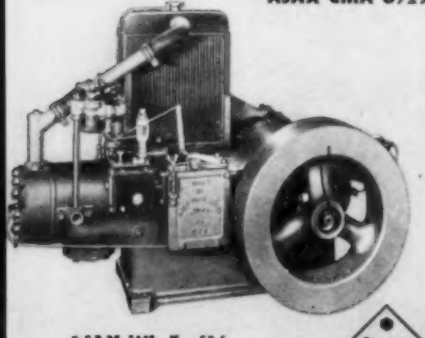
AJAX DP-115 13¼x16



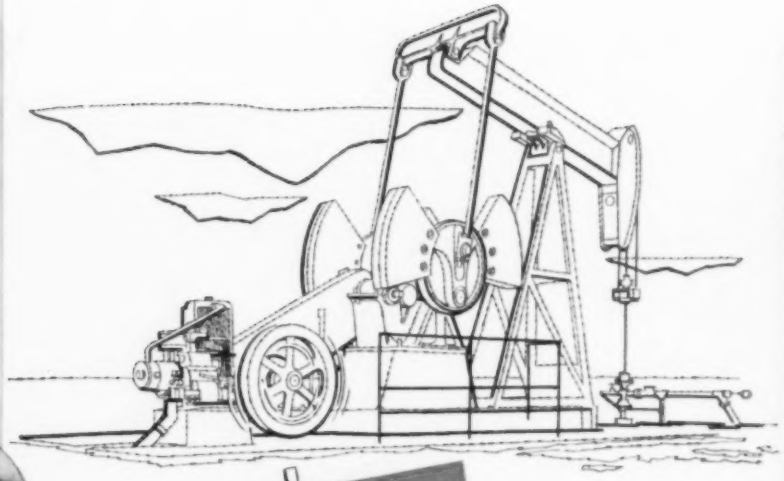
AJAX DP-70 11x14



AJAX CMA 8½x10



AJAX WL 5x6½



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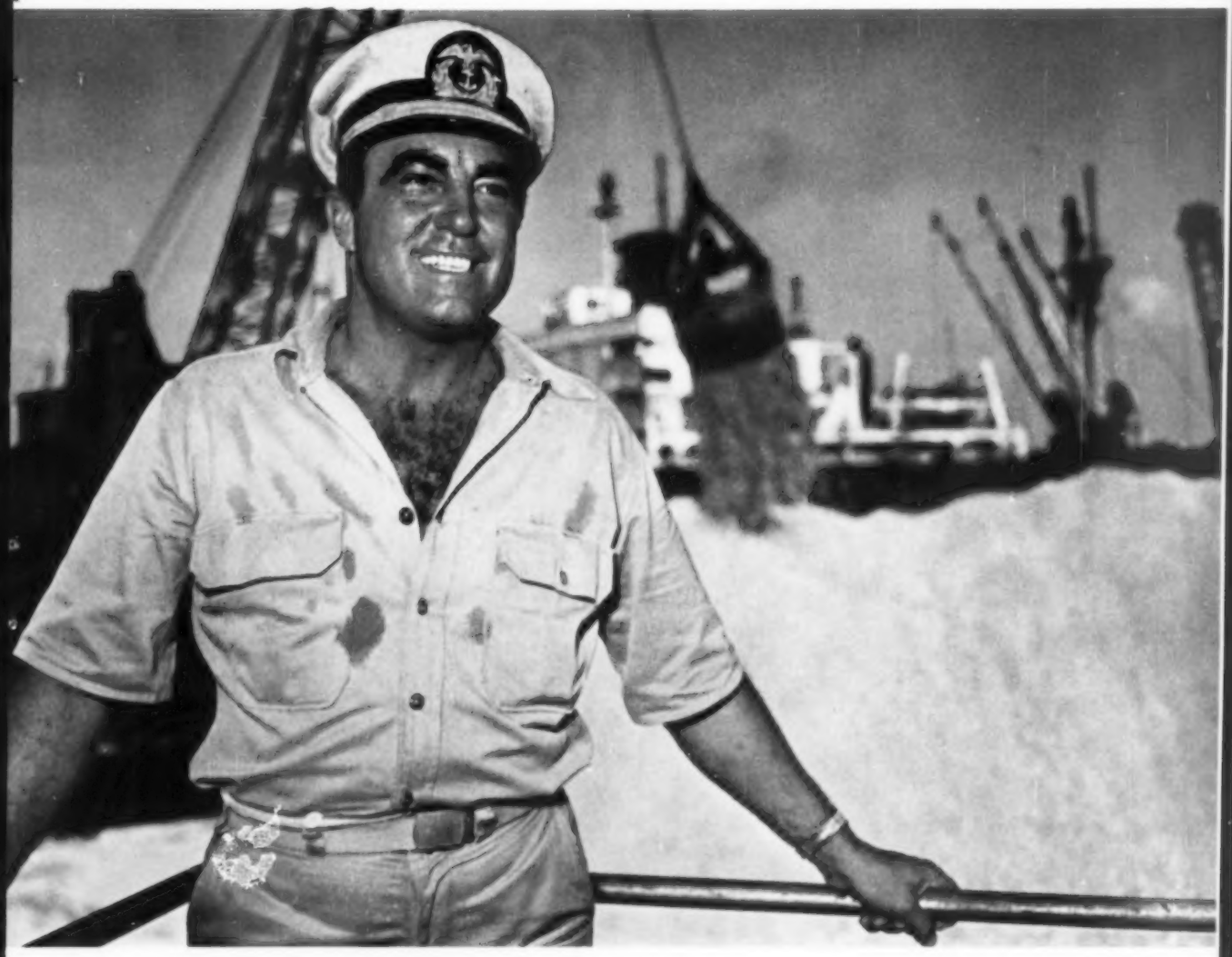

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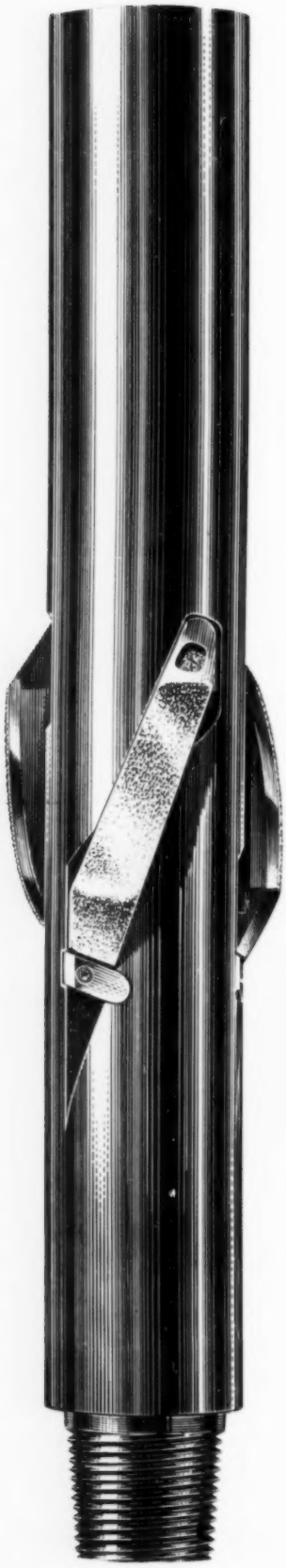

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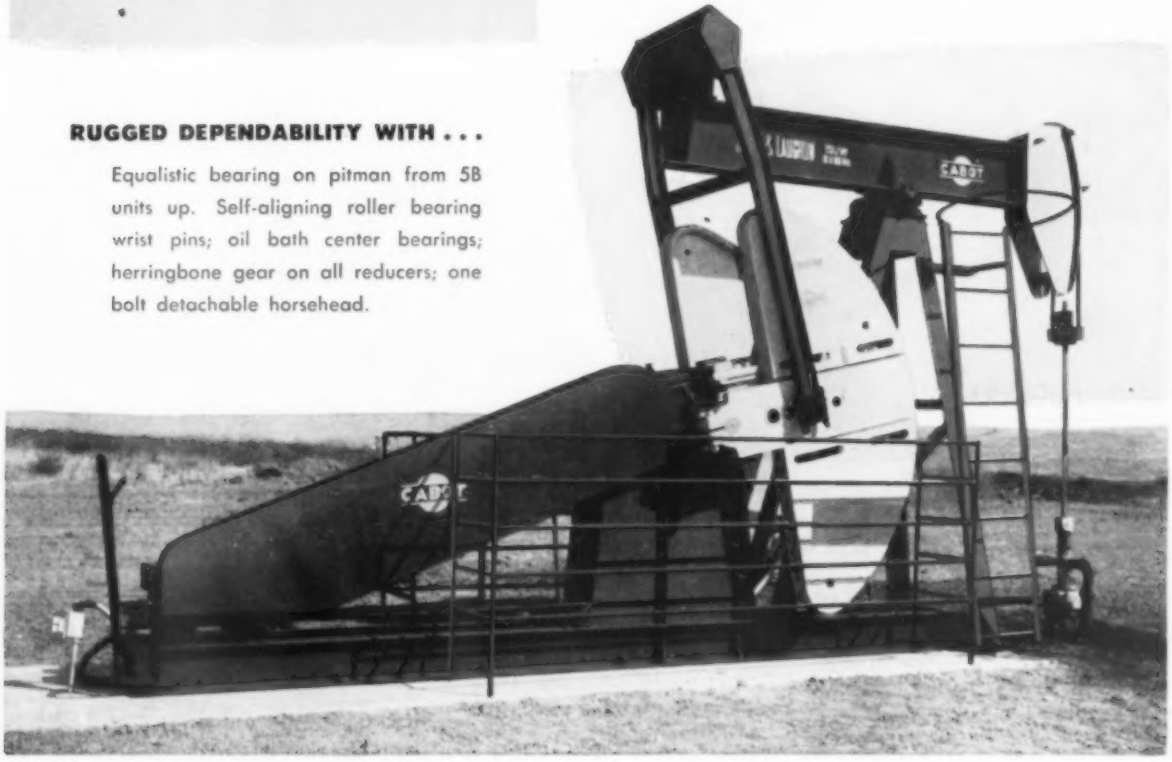

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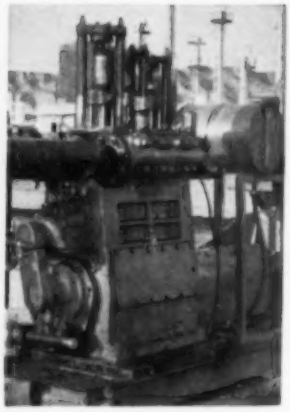

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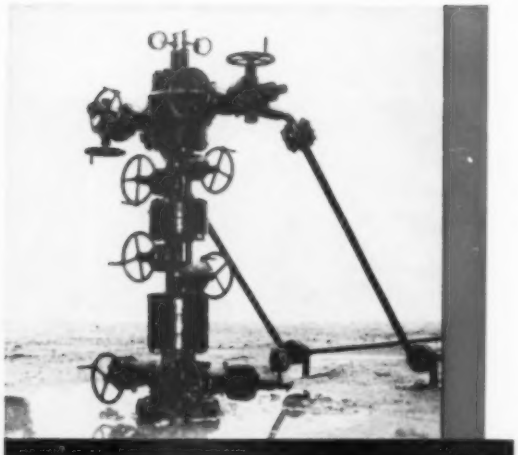

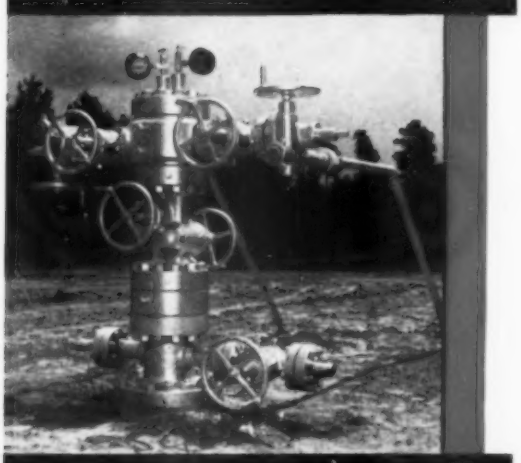

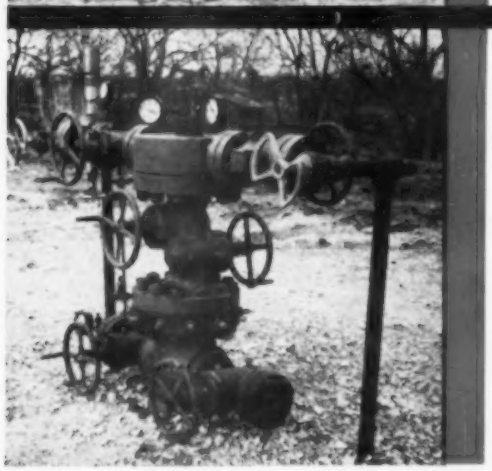

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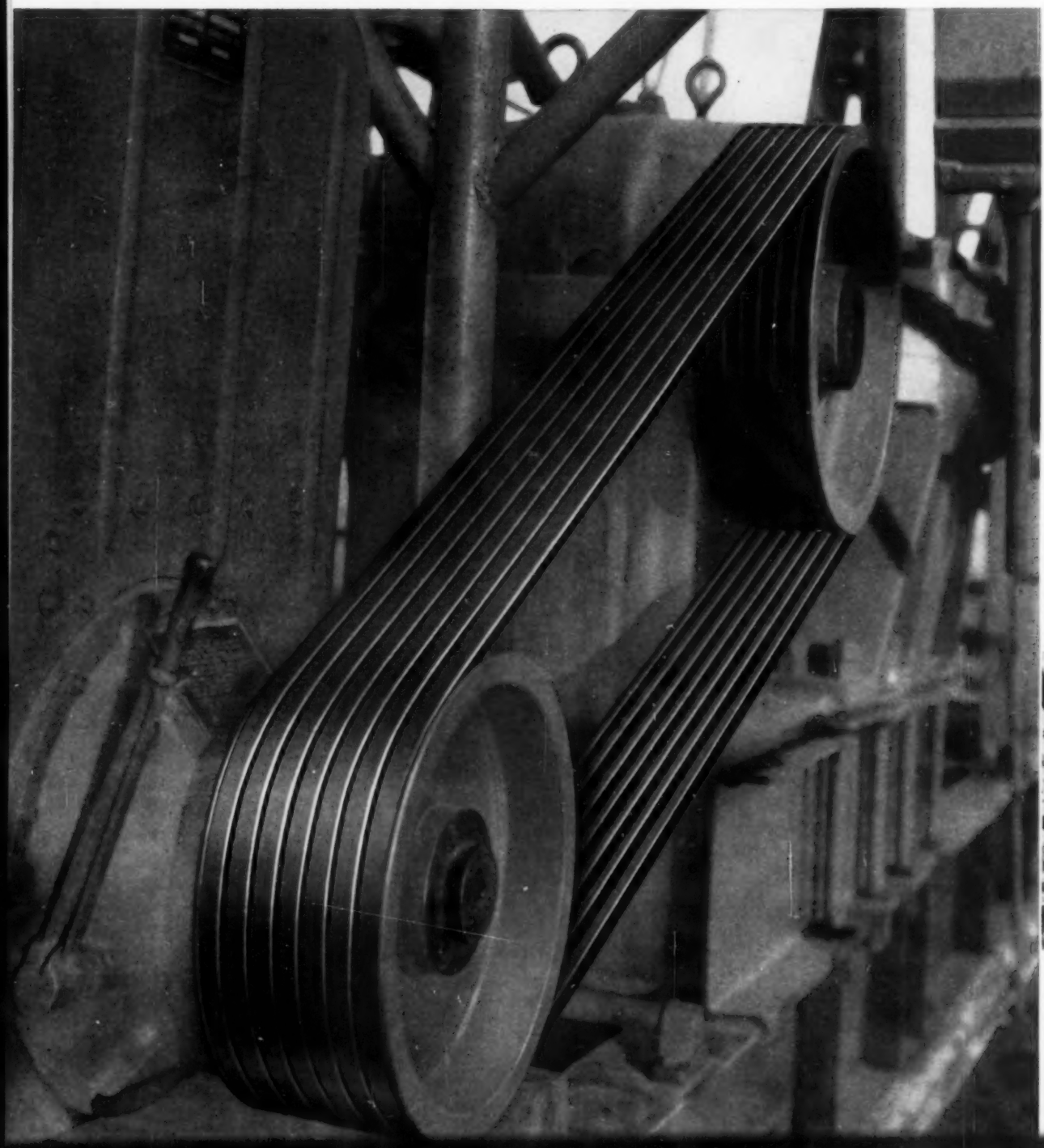

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Behind the long, dependable, month-after-month service you get from every set of Dayton V-Belts is the Dayton practice of *multi-matching*.

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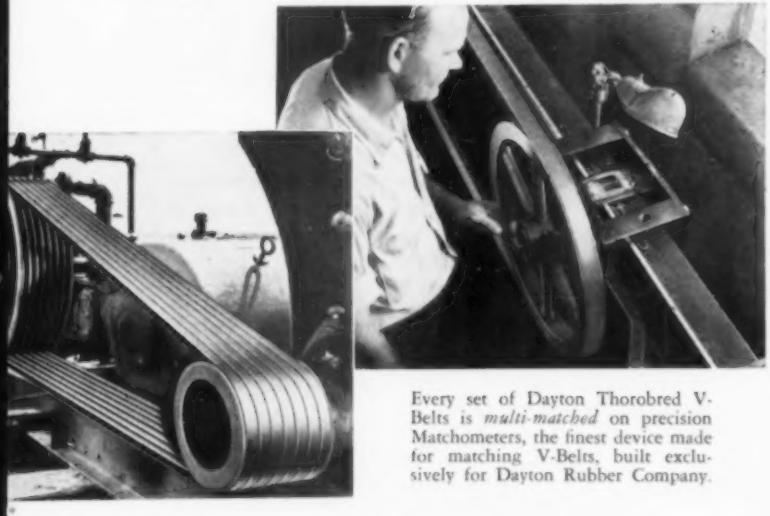

Every set of Dayton Thorobred V-Belts is *multi-matched* on precision Matchometers, the finest device made for matching V-Belts, built exclusively for Dayton Rubber Company.

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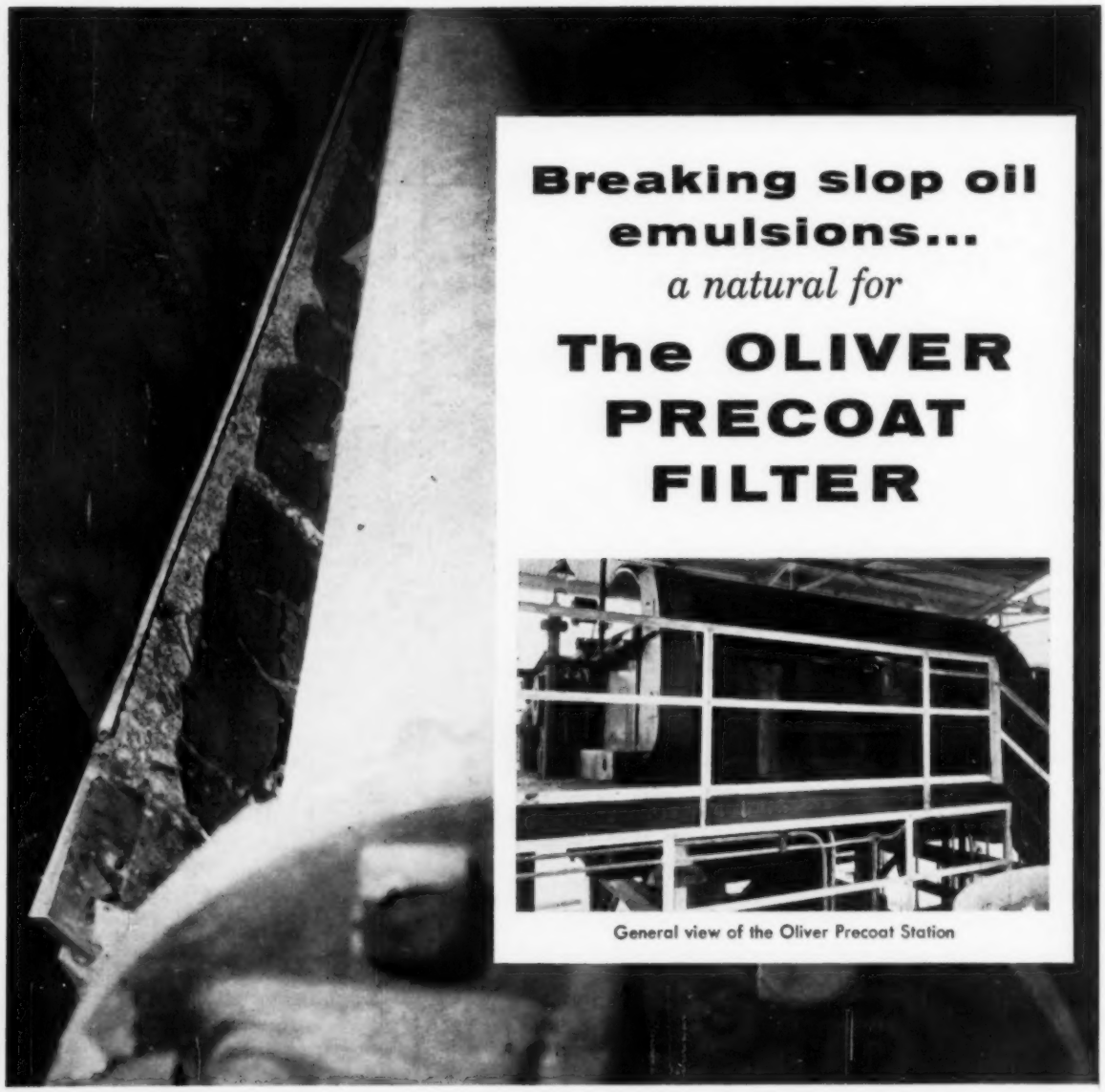

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The OLIVER PRECOAT FILTER

General view of the Oliver Precoat Station

Closeup of knife edge discharger clearly showing thin film of precoat and cake being continuously removed.

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The problem . . . continuous and economical removal of colloidal solids such as clay, coke, carbon, catalyst and some chemical emulsifiers from refinery slop oils thus permitting the separation of oil and water.

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Report on Traveling Blocks

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These fast (low center of gravity) Shorty Blocks can be unitized with the spring-loaded hook and link supports to add as much as 9 feet of headroom.

The safety lock is automatic, the hook ingenious, and a patented hydraulic cushion provides jarless starts and stops.

The big news in any present-day report on traveling blocks is the IDECO Shorty (capacities to 480 tons) and companion crown blocks (capacities to 560 tons). Get your J&L Supply store on the telephone now!

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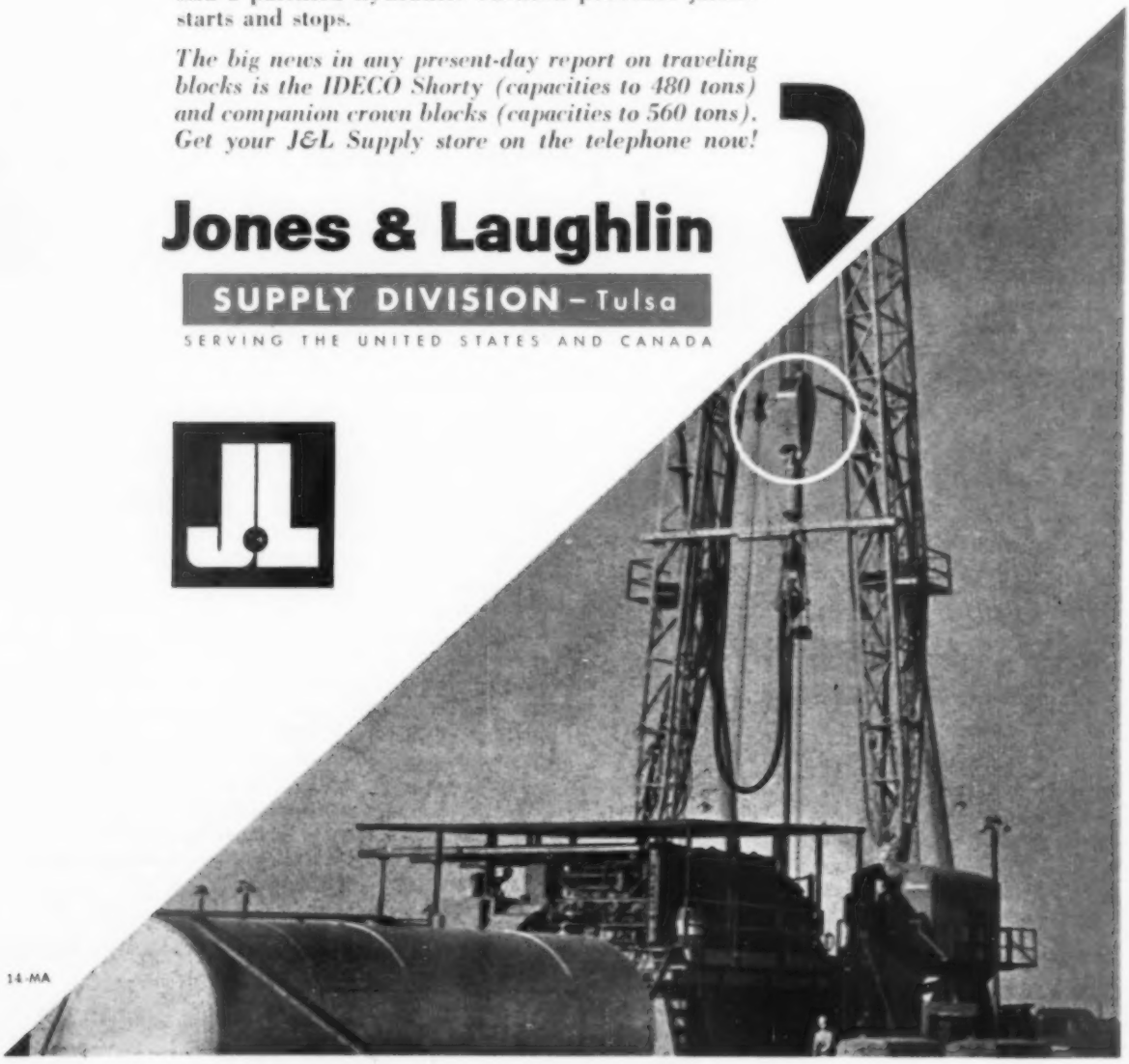

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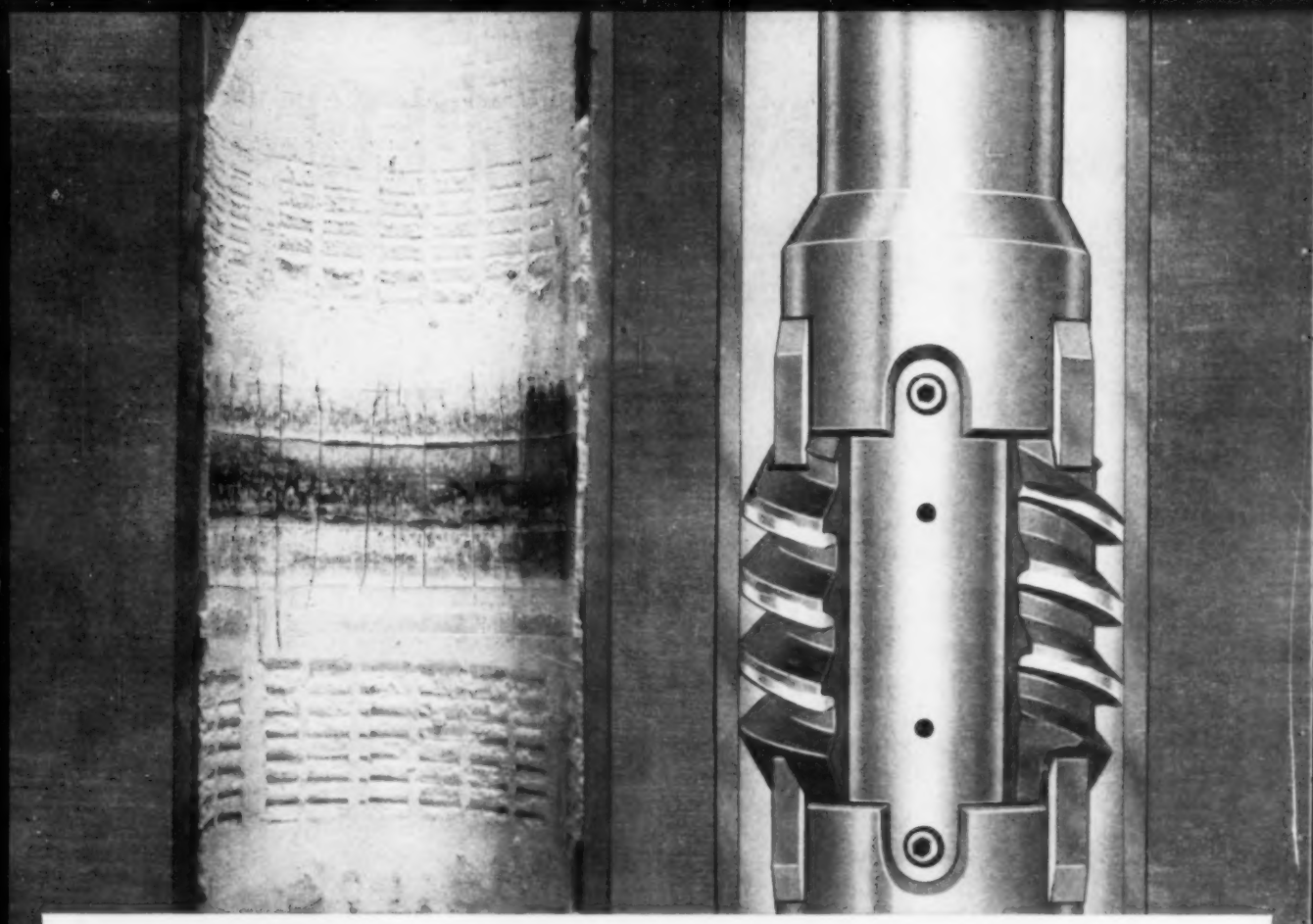


CAN YOU AFFORD *Not* to scrape your casing ...the Baker way?

You can't buy insurance for each job—so do the next best thing . . . keep your casing clean with the . . .

BAKER

This is just another way of asking "CAN YOU AFFORD THE EXPENSE OF DOWN-HOLE EQUIPMENT FAILURES?" The unretouched photograph at the above left provides visual proof of how casing neglect can cause even the best pack-off tool to fail.

In this case the pack-off tool set and packed-off perfectly—but the casing ID failed to do its part. Notice the cracks in the cement sheath in the area where the Packing Element was packed-off. *These cracks allowed the fluid under pressure to by-pass, even though the tool was securely set and completely packed-off.*

The Baker Roto-Vert Casing Scraper, which can be run on tubing, drill pipe or wire line, completely removes cement sheath and other obstructions such as perforation burrs and imbedded bullets—prepares the casing ID for subsequent work with pack-off tools. Remember, the condition of your casing ID is just as important to the successful operation of pack-off tools as the condition of a valve seat is to the operation of a valve.

Why take chances with so much at stake? The safe, positive, economical way to eliminate failures, such as the one illustrated above, is to make the running of a Baker Model "C" Roto-Vert Casing Scraper a part of your standard operating procedure.

BAKER OIL TOOLS, INC. • HOUSTON • LOS ANGELES • NEW YORK

ROTO-VERT CASING SCRAPER

PRODUCT NO. 620-C

A known fault zone, existing shallow field + conspicuous absence of Edwards production, a producer's study =

The FASHING FAULT FIND

Lone Star Producing Company's Edwards lime fault zone discovery in South Texas points to growing trend to trap-type field exploration

Robert M. Knebel
District Geologist
Lone Star Producing Company
San Antonio, Texas

LONE Star Producing Company's Edwards lime gas-condensate discovery in Atascosa County, South Texas, has indicated a significant natural gas reservoir on the Fashing fault block.

Discovery well, completed in October, 1956, was the No. 1-A L. T. Urbanczyk. A confirmation well is now near completion. The new Fashing (Edwards lime) field is 50 miles south and slightly east of San Antonio and 12 miles southeast of the Pleasanton (Edwards lime) field. On the initial potential test, the Urbanczyk well flowed (natural) 36,000,000 cu ft of gas plus 23.75 bbl per MMcf of condensate.

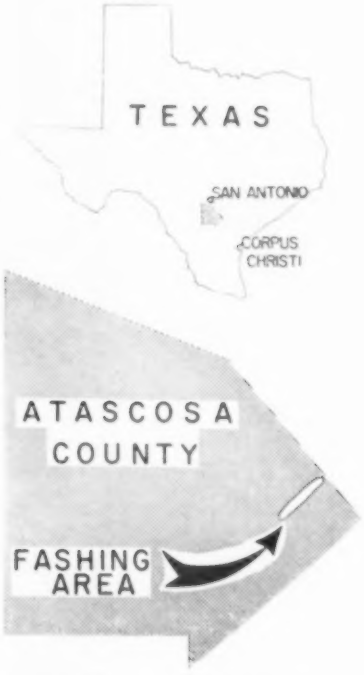


Fig. 1. **Fashing area discovery** in Atascosa County is about 50 miles south of San Antonio and 12 miles southeast of Pleasanton field, where Lone Star has been operating several wells producing oil and condensate from the Edwards limestone.

Geological Strategy

The geological concept that when an accumulation of oil and/or gas is found in one bed on the upthrown side of an up-the-coast fault in this area, and if that fault is the dominant sealing factor, drilling is apt to reveal additional producing zones on the same fault block. This theory is not new, but it led to the Fashing (Ed-

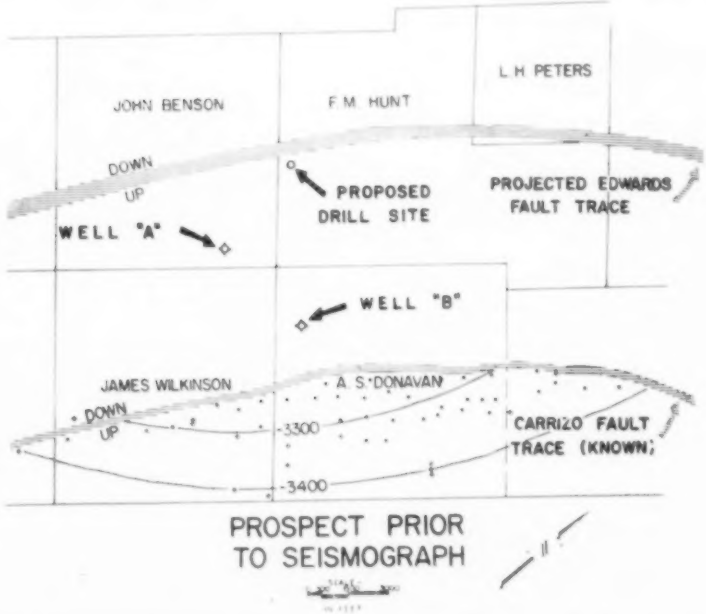


Fig. 2. **Prospect for drilling** to the Edwards lime looked like this prior to seismograph. Only these two wells, A and B, had penetrated the Edwards in the immediate area. Note the oil producing wells producing from the Carrizo, on the upthrown side of the Carrizo fault trace.

wards) discovery and will very probably be responsible for locating many similar trap-type fields in the future.

In the course of the Lone Star work, it was noted that closure was present in the Fashing area on a known fault zone having a throw of approximately 300 ft at the 3700 ft Carrizo-Wilcox level. Closure at this depth has been proved by Carrizo oil production. Absence of Edwards production against the Edwards trace of this fault was conspicious and inconsistent with other similar situations in the county.

This study of the Fashing block revealed that one dry hole, the H. R. Smith No. 1-A Schumann, located approximately 5000 ft south-southeast of the discovery, cut the Fashing fault 4000 ft above the Edwards, and that another dry hole, the Gulf Oil Corporation No. 1 Tom, located about 4200 ft south-southwest of the discovery, cut the fault 1700 ft above the Edwards lime, with apparent displacement of some 370 and 460 ft, respectively.

The Gulf dry hole had gas shows in the upper 90 ft of Edwards lime and it was believed that considerable additional structure could be gained by a well located in a northerly direction from the Gulf No. 1 Tom without placing such a location in hazardous proximity to the fault zone.

Condensate and Gas Reserves

This strategy resulted in the drilling of the Urbanczyk discovery. This was

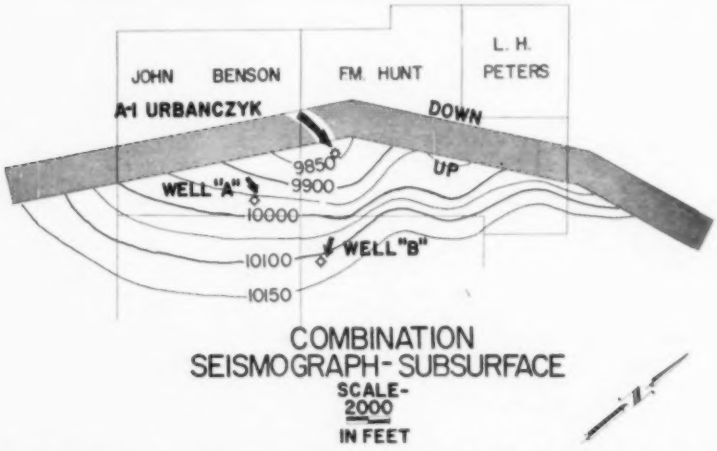


Fig. 3. **Combination seismograph-subsurface** anamoly plotted the Edwards lime in the Fashing fault block like this. In staking the Urbanczyk well, Lone Star believed it could gain considerable additional structure in placing the well in a northerly direction from the dry Gulf No. 1 Tom (Well B) without placing it in a hazardous proximity to the fault zone.

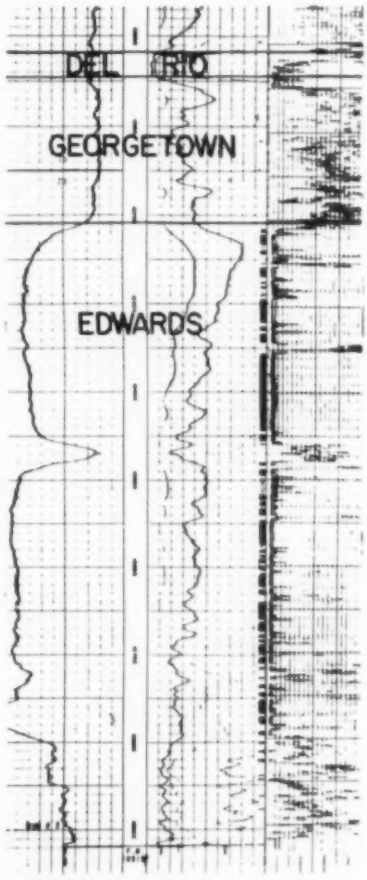


Fig. 4. **Electric and microlog surveys** in the Urbanczyk well. Edwards lime was topped at 10,210 ft and yielded 580 ft of good to fair porosity followed by 69 ft of inferior porosity.

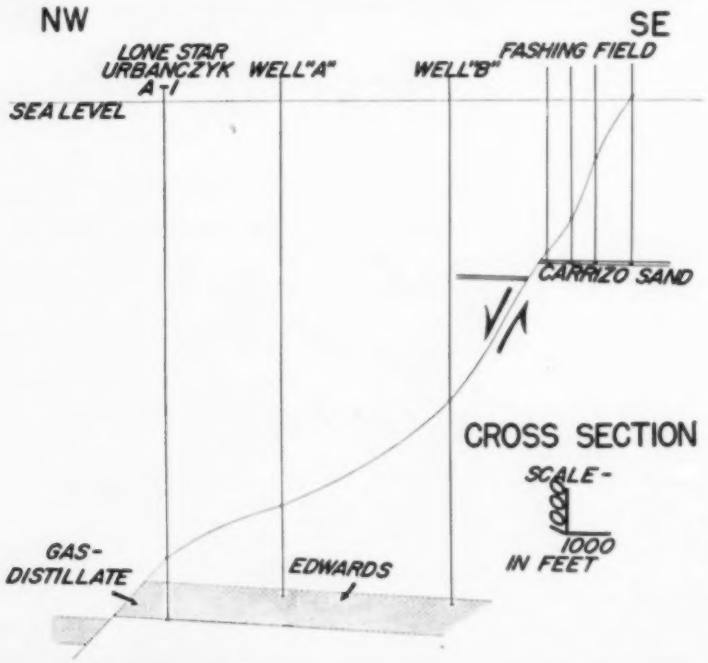


Fig. 5. **Cross section of the Fashing fault.** Closure was present in the Fashing area on the known Carrizo fault zone having a throw of 300 ft at the 3700 ft or Carrizo-Wilcox level, such closure proved by oil production at this depth. Dry holes shown here revealed displacement of 460 ft and 370 in dry holes B and A.

drilled on a block of some 3500 acres. Although gas reserves in this as yet undefined trap are not known, it is estimated that 1000 acres having reservoir characteristics comparable to those at the discovery location would assure gas reserves in excess of 400 billion cu ft. If 1000 acres of the 3500-acre block should prove productive to this extent, then liquid reserves, at an average of 20 bbl per MMcf, would be on the order of 8,000,000 bbl.

Site of the discovery well is 1517 ft from the SW line and 2660 ft from SE line of F. M. Hunt Survey 149.

580 Ft of Pay

In this well the Edwards lime was topped at 10,210 ft on ground elevation of 399 ft. Cores from the entire section, consisting of 580 ft of good to fair porosity followed by 69 ft of inferior porosity, were analyzed and described by the laboratory as being productive of gas and condensate.

Electric and microlog survey was corroborated by taped measurements of porous sections in the cores in which more than three-fifths of each core was actually porous. This measurement included good, vugular, trace, pinpoint and earthy types of porosity.

Production Tests

Initial production test was made through perforations between 10,420-10,430 ft in 5½-in. casing cemented at 10,919 ft on total depth of 10,921 ft. On a 12/64-in. surface choke, the well flowed at the rate of 3,014,000 cu ft of gas per day. Separator recovery was 15.50 bbl per MMcf of 51.6 deg condensate. Tubing flowing pressure was 3940 psi. Separator pressure was 600 psi.

Testing on a ¼-in. surface choke, the well flowed at the rate of 5,410,000 cu ft per day. Tubing flowing pressure was 3919 psi and separator pressure was 1350 psi. There was no gage on fluid production.

A third production test at this interval, on a 22/64-in. surface choke, produced at the rate of 9,456,000 cu ft per day. Liquid recovery was 15.30 bbl per MMcf per day of condensate. Tubing flowing pressure was 3726 psi and separator pressure was 1000 psi. Reservoir shut-in pressure was 5162 psi and shut-in surface tubing pressure was 3986 psi.

Perforations between 10,420-430 ft were then squeezed off and pipe was perforated between 10,790-816 ft and 10,824-850 ft. A production test through these perforations produced gas at the rate of 5,058,000 cu ft per day through ¼-in. surface choke with 3500 psi working tubing pressure. A light straw-colored condensate accompanied the gas production from this lower interval at the rate of 23.75 bbl per MMcf.

Earlier, six drillstem tests in the Urbanczyk well recovered gas or gas-condensate. These tests were conducted from 10,181-331 ft, 10,224-331 ft, 10,335-450 ft, 10,450-550 ft, 10,550-650 ft and 10,650-749 ft.

Confirmation Well

Lone Star Producing's confirmation well on the Fashing block is nearing completion. Early reports are promising. This well is the No. 1-A Tom, located 3200 ft southwest of the No. 1-A L. T. Urbanczyk discovery. This second test topped the Edwards lime at 10,236 ft, with top of Edwards porosity at 10,240 ft. Ground elevation on the Tom well is 373 ft. Base of the Edwards was called at 10,884 ft for a total of 648 ft of Edwards section. Total depth of the confirmation well is 13,964 ft. A 5½-in. liner was set at 11,576 ft. Induction electric logs, micrologs and limestone survey was run to total depth. Tubing has been run. All of the Sligo (Petit equivalent) was drilled and tested. Top of the Sligo (picked by geologist) was 12,830 ft.

Discovery Importance

Lone Star Producing Company, wholly-owned subsidiary of Lone Star Gas Company, through this discovery has increased future marketability of Pleasanton area gas reserves which the company has been building in this region for several years. Also, it lends considerable importance to the value of trap-type fields similar to this one found on the Fashing fault block.★ ★

The Author

Robert M. Knebel is district geologist for Lone Star Producing Company in South Texas. He was a graduate of Texas A&M College in 1949 and since that time has been in Lone Star service. Knebel began as assistant geologist in Athens, Texas, and became geologist in June, 1953. He was transferred to Colorado City in March, 1950, later worked in Dallas and then San Antonio in March, 1954.

Knebel is a member of the South Texas Geological Society and American Association of Petroleum Geologists.

Geologists Conduct Texas U Courses

Two short courses in geology will be conducted by visiting geologists at the University of Texas during January and February, Dr. S. P. Ellison, Jr., geology department chairman, has announced.

First of the visiting professors will be Dr. Grover E. Murray of Baton Rouge, Louisiana, who will conduct a three-week course on the geology of the Gulf Coastal Plain beginning January 2.

Dr. Murray, professor of stratigraphic geology at Louisiana State University, is a foremost expert on Gulf Coast Tertiary Geology. He formerly was geology department chairman at Louisiana State University and a geologist with Magnolia Petroleum Company and with the Louisiana Geological Survey. For several years he was editor of the American Association of Petroleum Geologists Bulletin and AAPG Journal of Paleontology.

Robert P. Sharp, California Institute of Technology geology department chairman, will conduct a short course on "The Newest Trends in Study of Land Forms." The course, beginning February 11, will continue for a two or three-week period, Dr. Ellison said.

Dr. Sharp, widely-known authority on geomorphology, has also taught at the University of Minnesota.

Both courses will be offered for graduate credit, Dr. Ellison said.

A full-time visiting professor during the spring semester will be Dr. Lowell G. Biddulph, geology and geography professor at Ricks College, Rexburg, Idaho. For the past 18 summers he has been a ranger naturalist at Yellowstone National Park and has contributed numerous articles to the Yellowstone Nature Magazine.

Dr. M. G. Mehl, University of Missouri professor who will lecture in the geology department for a three-day period in March, will speak on "Life of the Geologic Past."

DRILLING REVIEW AND FORECAST

- **58,200 well completions in 1956; drillers make 235,000 ft of hole — 4 percent more than in 1955**
- **More wells, deeper drilling — one percent more activity — means still fewer rigs running**
- **Steel shortage, Suez situation key to an erratic drilling year**

Jack H. Abernathy, *President*
American Association of Oilwell Drilling Contractors

EVERY petroleum authority predicted that 1956 would be a record year for the U. S. drilling industry. With the totals still coming in, it appears the prediction was proved correct. It took the Suez situation, however, to bring this about.

The year's completions are estimated at 58,200 wells, with total footage of 235,000,000, for a gain of about 4 percent over 1955, the previous record year.*

The outlook for 1957 is for somewhat increased drilling activity, although just how much greater depends on a number of variables — including the outcome of the Middle East crisis and settlement of the imports question.

Currently, the best guess is that U.S. crude producers will have a considerably increased foreign demand (about 800,000 bbl per day) for about six months, with diminishing foreign requirements to the remainder of the year.

At times in the latter part of 1956, following the midsummer steel strike, it appeared that drilling might not reach the higher levels forecast last January.

Statistically, the year past was one of peaks and valleys for oil well drilling contractors, contrasted with the steadily-paced acceleration of 1955 operations. The year began with a high level of drilling activity that seemed quite likely to break all previous drilling records by wide margins.

Total rotary rigs running in the U.S. and Canada, in January, were about 20 percent ahead of the previous year's opening month. Following the traditional seasonal drop in activity in February, drilling picked up again in the succeeding months and maintained a substantial lead over 1955 rates until June, when the steel strike's dampening effects were evidenced by a sharp drop in rig operations. By August, about 170 fewer rigs were in operation than in the same month of 1955.

The pattern was repeated in exploratory drilling although with a lag of a month or two. Records were set in July and exceeded again in August. Before the steel shortage took its toll, wildcatting showed a gain of 13.4 percent over the similar period of 1955. By November, the shortage of tubular goods had made inroads in exploratory well completions, cutting the year's gain to 10 percent.

An interesting sidelight on drilling activity in 1956 is a comparison of the three charts on rotary rigs running, footage drilled and well completions. While the number of rotaries working declined substantially in July and never again reached the peak number active in June, this was not immediately reflected in the record of completions and footage. It is apparent that the short supply of tubular goods reduced operations levels considerably at that time.

August chalked up the year's high points in both completions and footage. In the following month, the steel scarcity caught up and for the first time all year, well completions in September fell below the mark of the comparable month of 1955.

Field development drilling was hardest hit, as operators channeled available steel inventories to drilling starts on exploratory wells where lease obligations had to be met immediately. Smaller operators, with limited tubular goods stocks, were affected more than the major companies.

Just as it took a little time for the steel shortage to impair well completion rates, these was also a delayed reaction—not yet fully realized—on drilling costs. Oil country casing and drill pipe prices increased by about $14 per ton, with comparable rises in the costs of bits and other steel goods used in drilling. It is indicated that contractors' direct cost increase from higher steel prices alone is about $20 to $40 per rig per day, *not* including the increased reserves necessary for replacement of equipment at higher price levels.

Added to these cost increases was a steady rise in wages, a step necessary to maintain skilled crewmen on the job.

(Continued on Page B-26)

*Statistics compiled by the AAODC

PRODUCERS' 1956 RECORD, '57 AIMS

- **U. S. daily productive capacity reached more than 10,000,000 bbl in 1956**
- **Middle East to be biggest 1957 influence on domestic oil and gas producing industry**
- **4½ billion bbl of new oil must be found in the U. S.!**

Robert L. Wood, *President*
Independent Petroleum Association of America

THE New Year in the oil industry is marked by unsettled Middle East conditions in which oil supply to important areas of the Free World has become a primary consideration. In this critical situation, domestic oil producers in the United States have become the shock troops in an economic war to provide supplies to an oil famined Western Europe.

Fortunately for our country and the Free World, increasing supplies of petroleum were provided by domestic oil and gas producers in 1956. Producers in the United States recorded outstanding accomplishments despite increasingly serious economic conditions within the industry. Although gains were made in exploration and drilling, they were not as great as in 1955 and did not keep pace with the increases in either production or demand.

The significant developments in the petroleum industry during the past year were:

1. The drilling of 57,500 wells with the result that U.S. petroleum productive capacity reached more than 10 million bbl daily at the end of 1956.

2. The Middle East crisis which abruptly altered world oil movements and will be one of the greatest influences on developments in the domestic oil and gas producing industry in 1957.

3. Increased recognition by government that a sound and progressive domestic petroleum industry is our first line of defense for ourselves and the Free World, and concerted though unsuccessful governmental efforts to effectively limit oil imports in the interest of national security.

The Suez crisis and the disruption of Middle East oil supplies has had the related results of: (1) Creating demands for substantial increases in U.S. oil production to offset critical winter fuel shortages now facing Western Europe, and (2) dramatizing the vital necessity of domestic oil supplies in the preservation of world peace.

Oil supplies in the United States have been a primary force enabling the progress toward peaceful settlement of the Middle Eastern difficulties. Because of our abundance of oil, we did not have to submit to the demands of foreign governments or resort to war. We need not have to in the future.

By its performance, the domestic petroleum industry has demonstrated that we can continue to have adequate oil for other emergencies in the foreseeable future.

In the critical developments resulting from the reduced flow of Middle East oil, the domestic oil producer in the United States has become a man of the hour. I hope he does not become the forgotten man when the normal flow of oil from the Middle East fields is again restored.

Domestic Industry in 1956

The statistical record of the oil and gas producing industry in 1956 is revealed in the attached table.

Total U.S. production of petroleum liquids increased 5½ percent in the past year. Total domestic and export demand likewise increased about 5½ percent. However, the drilling of wells—the most costly and necessary function of the industry and the key to future petroleum supplies—increased less than 2 percent. This is a direct reflection of the growing insufficiency of funds available for exploration, drilling and development.

The very slight rise in drilling in 1956 compares with an increase of more than 5 percent in 1955. A number of factors contributed to this lesser rate of increase. The primary influence was the fact that crude oil prices remained unchanged while producers continued to absorb increasing costs for steel, materials, services and wages. Coupled with this was an unrealistic restriction of markets imposed by

(Continued on Page B-27)

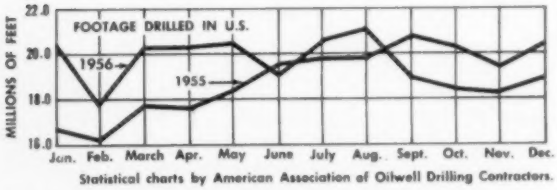
DRILLERS:

"59,000 wells will be drilled in '57"

Contractors have traditionally held the line against increased drilling costs through increased penetration rates—in other words, getting more footage in faster time. Since 1941, there has been at least 88 percent improvement. It appears that there was some continued speed-up in 1956, since more wells and more footage were drilled with about the same average number of rigs as were used in 1955. The improvement was not enough, however, to offset the higher costs.

Contractors now drill 93 percent of the nation's oil and gas wells, and are faced with a bigger job next year.

Operators plan drilling budgets on the basis of demand and markets for petroleum. Total U.S. demand in 1957 is expected to increase 4.1 percent over 1956, from an average

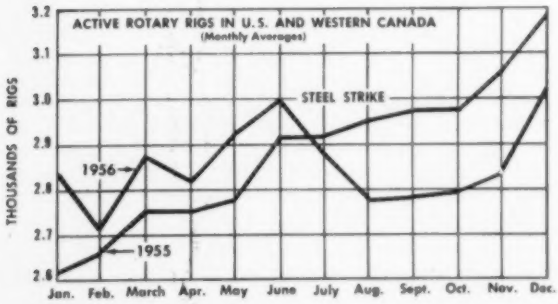


Statistical charts by American Association of Oilwell Drilling Contractors.

Total footage drilled in 1957 exceeded 235,000 ft. August was the peak month for making hole, followed by the slump caused by lack of pipe due to the steel strike. At this point, the figure never rose above 1955 marks.

of 8,899,000 bbl daily to 9,265,000. Most of this need will be supplied from domestic production, which is expected to increase 2.6 percent over the 1956 daily average of 7,100,000 bbl.

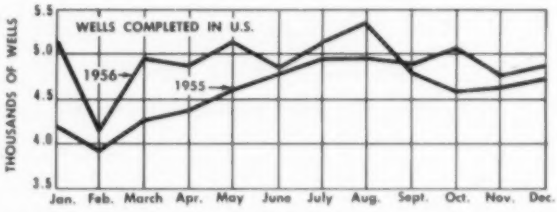
The net effect of this forecast on the drilling industry, especially in view of the uncertainties surrounding the Suez situation, could be a moderately stepped-up drilling program in the U.S. and other Western Hemisphere producing countries. Nevertheless, domestic producers are proceeding cautiously in planning increased expenditures for drilling, seeming to adopt a wait-and-see attitude toward the curtailment of Middle East supplies.



Number of rotary rigs active varied much from month to month contrasting sharply with the smooth and steady rise of rigs active in 1955.

Some Washington sources predict that in the interest of national defense, the Office of Defense Mobilization may order a cutback in crude imports to near the 1954 ratio to domestic production, after the current emergency is resolved.

These various events could mean enlarged drilling programs to maintain adequate domestic reserves and to allow for increased production. If these developments do not occur, a late December forecast indicated that U.S. producers' planned 1957 budgets called for only a 1 percent



Well completions in the U. S. during 1956 were estimated at 58,200 by the AAODC. The drillers set the record using fewer rigs than were used to drill the 56,000 wells drilled in 1955. It is estimated that the shortage of tubular goods in the latter months of the year cut short even greater records.

increase in drilling and production capital spending. This would result in a reduction in average number of rigs operating.

Summing up, overall operations levels for 1957 should be quite close to 1956 averages. Costs to the contractor will be considerably greater and part of this necessarily will be reflected in higher footage prices, as average penetration rates will probably not increase sufficiently to allow contractors to absorb the cost increases.

The U. S. Petroleum

	Unit	1955	1956 (Prelim)	Increases 1956 over 1955 In units	In percent
Exploration and Development					
Exploratory crews active	Number	665	625	—40	—6.0
Rotary rigs active	Number	2,685	2,625	—60	—2.2
Wildcat wells completed	Number	12,271	13,000	729	5.9
Development wells completed	Number	44,411	44,500	89	.2
Total wells completed	Number	56,682	57,500	818	1.4
Oil wells completed	Number	31,567	30,900	—667	—2.1
Gas wells completed	Number	3,613	4,100	487	13.5
Service wells completed	Number	760	1,000	240	31.6
Dry holes	Number	20,742	21,500	758	3.7
Total wells	Number	56,682	57,500	818	1.4
Total footage drilled	1000 ft	226,270	230,000	3730	1.6
Production and Producing Capacity					
Production:					
Crude oil	1000 bbl daily	6,807	7,160	353	5.2
Natural gas liquids	"	725	790	65	9.0
Total	"	7,532	7,950	418	5.5
Producing capacity:					
Crude oil	"	8,710	9,160	450	5.2
Natural gas liquids	"	790	840	50	6.3
Total	"	9,500	10,000	500	5.3
Shut-in capacity:					
Crude oil	"	1,903	2,000	97	5.1
Natural gas liquids	"	65	50	—15	—23.1
Total	"	1,968	2,050	82	4.2

Sources of Data:
Exploratory crews from Interstate Oil Compact Commission,
Rotary rigs active from Hughes Tool Company,
Wells completed and footage drilled from Oil and Gas Journal,
Production, imports, exports and demand from U. S. Bureau of Mines

PRODUCERS:

"65,000 U. S. wells should be drilled"

excessive imports which increased 13 percent in 1956 despite the concern of our government and efforts by the Office of Defense Mobilization to bring about voluntary import reductions.

This trend is illustrated in the following statistical highlights of the industry's 1956 performance:

Accomplishments of Domestic Oil Producing Industry in 1956.

	Year 1956 (Prelim)	Percent Increase over 1955
U. S. Exploration and Development		
Total wells drilled (number)	57,500	1.4
Total footage drilled (mil ft)	230	1.6
U. S. Production and Producing Capacity		
Crude Oil and Natural Gas Liquids		
Average producing capacity (bbl daily)	10,000,000	5.3
Average production (bbl daily)	7,950,000	5.5
Average shut-in production (bbl daily)	2,050,000	4.3
U. S. Demand for Liquid Petroleum		
Domestic demand (bbl daily)	8,850	5.2
Export demand (bbl daily)	410	12.3
Total demand (bbl daily)	9,260	5.5
Employment		
Total number of employees	321,000	2.9

An increasing disparity in crude oil prices continues as the greatest threat to the development of domestic petroleum supplies for the future. Cumulative increases in industry costs seriously aggravated this problem in 1956. Average hourly wages increased 8 percent, oilfield machinery 6 percent, and oil country tubular goods 10 percent. Since June, 1953, the date of the last increase in crude oil prices, wages have increased 16 percent, oilfield machinery 16 percent, and tubular goods about 25 percent. These factors do not take into account other rising costs due to drilling and the necessity of drilling a larger number of wells each year.

Further increases in both wages and steel are forthcoming in 1957. Unless crude oil prices are increased early, it is obvious that domestic producers will have neither the funds nor incentive to continue exploration, drilling and development activities on the scale required.

Prior to the Suez crisis, the domestic industry was handicapped by a number of unhealthy conditions. These included excessive imports, restricted markets, thousands of wells without pipeline connections and additional thousands subject to pipeline proration, and wasteful levels of oil inventories throughout the year. The effect of these conditions were reflected in a 6 percent decline in active exploration crews in the United States, a limitation of domestic oil transportation facilities which is hampering the present program of supplying oil to Europe, and disruption of state oil and gas conservation programs.

What effects the Middle East crisis will have on these conditions remain to be seen. However, the months ahead provide an opportunity to take stock of our requirements for the future and to implement policies which will encourage a maximum development of domestic petroleum.

Industry in 1956

	Unit	1955	1956 (Prelim)	Increases 1956 over 1955 In units	In percent
Imports and Exports					
Imports:					
Crude oil	"	782	930	148	18.9
Refined products	"	466	485	19	4.1
Total	"	1,248	1,415	167	13.4
Exports:					
Crude oil	"	31	80	49	158.1
Refined Products	"	334	330	−4	−1.2
Total	"	365	410	45	12.3
Net imports	"	883	1,005	122	13.8
Demand					
Total demand, domestic and export		8,781	9,260	479	5.5
Employment					
Number of employees	Number	312,000	321,000	9000	2.9
Hourly wages paid	Dollars per hr	2.32	2.50	.18	7.8
Cost Factors	Index numbers				
Hourly wages paid	1947–49=100	141.5	153.0	11.5	8.1
Finished steel prices	"	149.5	161.0	11.5	7.7
Oil field machinery prices	"	134.8	143.0	8.2	6.1
Line pipe, carbon	"	167.2	191.0	23.8	14.2
Oil well casing, carbon	"	151.5	162.0	10.5	6.9
Oil well casing, alloy	"	149.6	165.0	15.4	10.3
Prices					
Crude oil	Dollars/bbl	2.82	2.84	.02	.7
Four principal products	"	3.81	3.96	.15	3.9

Cost factors and employment from U. S. Bureau of Labor Statistics. Prices and producing capacity from IPAA.
Prepared by the Independent Petroleum Association of America, December, 1956.

Outlook in 1957

The domestic petroleum industry should be required to produce about 3 billion bbl of oil in 1957. This level could be expected under the program of stepped up production during the Middle East crisis. Or, assuming an early resumption of normal oil movements in the Middle East, this rate of domestic production could be anticipated under the announced government objective of holding total oil imports to their 1954 relationship to domestic production.

Anticipating production of 3 billion bbl, the domestic industry in the coming year should find and develop at least 4½ billion bbl of petroleum liquids. At least 1½ bbl of new domestic reserves must be discovered and developed for each barrel produced if we are to maintain proved reserves in keeping with our growing needs and in preparedness for any emergency.

The job of finding and developing 4½ billion bbl of new oil is one that requires full confidence and faith in our industry. Based on experience, it will mean that we should drill about 65,000 in 1957, or 13 percent more wells than in 1956. To accomplish this, the domestic industry would need to spend out of its income from the sale of crude oil and natural gas more than $6 billion for exploration, drilling and development.

This is no small challenge. It is, however, the most important task facing the petroleum industry. It is simple fact that to continue providing oil supplies sufficient for our nation's future security, the domestic industry must drill more wells, at higher cost, than ever before. To do this the industry must have both a market and a reasonable price for its oil.

Editors' Note: *Statements of both drilling and producing industry leaders presented here were made prior to the domestic crude price increases made early in January. These increases, doubtlessly, will have a marked effect on number of wells drilled, cost data, and other estimates presented.*

Does your operator-contractor drilling plan provide adequate safety provisions to cope with any blowout situation? Can your drilling crew close a well in 90 seconds? If not, then heed this plan and these suggestions for . . .

Blowout Prevention

Tom Gaines, *Chief Petroleum Engineer, Texaco Exploration Company, Calgary, Alberta*

BLOWOUTS are accidents.

Procedures to prevent blowouts follow the same general pattern as that of any accident prevention program. That is, a safe drilling plan executed by trained drilling personnel using adequate equipment can prevent most blowouts. If, in spite of all precautions, a blowout occurs, then employment of trained rig crews and good equipment will minimize the dangers to life and property.

We believe that the operator or owner of the well is responsible for the preparation of a safe drilling plan. We believe that the drilling contractor is responsible for the execution of this plan. Drilling contractors and safety personnel are vitally interested in blowout prevention and may find this viewpoint of value in efforts to make drilling safer.

Definition of a Blowout

A blowout may be defined as an uncontrolled discharge of gas and/or liquid from the well into the atmosphere. Blowouts are caused by loss of control over formation pressures. That is, blowouts occur only when formation pressures exceed the pressure exerted by the column of drilling fluid or mud. Conversely, blowouts can be prevented by the presence of a drilling mud column of proper density and height. Blowouts may be brought under temporary control by the use of surface equipment called blowout preventers. But, it is then necessary to rebuild the mud column to regain permanent control.

If a plan is devised that will establish a mud column which can control formation pressures, and the drilling crew trained to execute this plan, then most blowouts can be prevented. If blowouts occur the drilling crew must be trained, and the rig equipped, to regain control as rapidly as possible.

Drilling Plan, Operator's Responsibility

Preparation of a deliberate plan of operations for drilling is the first step in blowout prevention. This planning is the responsibility of the operator. Since the drilling of a well is a joint enterprise, the contractor should be encouraged to offer information and suggestions leading to the development of the best plan. The drilling program should be comprehensive, and copies of it should be given to the contractor in advance of the initiation of drilling. Essential parts of the drilling plan required to prepare a safe blowout prevention program include:

1. Prediction of subsurface conditions.
2. Casing program.
3. Mud program.
4. Special operations program including drillstem testing, coring, and electrical logging.
5. Completion program.

Prediction of subsurface conditions of the well should include anticipated formation tops, indicated zones of possible high pressure, prospective gas formations, and possible lost circulation intervals. The value of this prediction to the contractor is obvious in that he can use this information to select and design his drilling equipment and forewarn his crew of hole conditions that may result in blowouts.

Casing Program

The casing program must be designed for the specific well. Factors affecting casing design include the nature of the formations to be penetrated, proposed depth of hole, and the anticipated formation pressures. These factors are usually known in planning the drilling of developments and extension wells, hence, designing casing programs for such wells presents no problems. In wildcat drilling, where no data is available, longer and heavier than normal surface casing strings should be run.

In deep wells or in moderately deep wells where high pressure or lost circulation formations are anticipated, the casing program may be designed to include an intermediate string of casing. The casing program should contain procedures leading to securing a cement bond between casing and hole. The program should also contain details for pressure testing the casing and cement bond prior to continuing drilling operations to insure that the casing job will withstand anticipated formational pressures. The necessity of a good casing program in the prevention of blowouts cannot be over em-

Too late for planned prevention practices! Blowouts are controlled only by thinking ahead followed by premeditated action and implemented by crew indoctrination and repetitive drilling in use of BOP equipment.

This paper was presented at the Forty-fourth National Safety Congress, Chicago, Illinois.

Total loss of equipment is a certainty here. Blowouts may only be controlled by prevention, through execution of a safe drilling plan.

phasized because the casing strings are the foundations for the blowout preventer equipment.

Primary control of blowouts is the maintenance of a mud column of sufficient density to create a hydrostatic head greater than the formation pressures encountered. The hole must be kept full at all times to insure the maximum head. The mud program should call for measures to keep the bore full, that is, prevent lost circulation. The density of the mud column is affected by the mud properties of weight, viscosity, and gel strength. Optimum density is that which will develop sufficient head to offset formational pressures yet not cause lost circulation. A plan of mud weights or densities should be designed to effect optimum mud column density. In most wells a mud column density designed to give 300 to 500 psi hydrostatic pressure greater than the anticipated formation pressure is satisfactory. The density of a mud column and the pressure that it exerts at the formation, may be affected indirectly by the viscosity and gel strength of the mud. High viscosity and high gel strength muds are easily gas cut, and are more likely to be "swabbed" from the hole while pulling tools. Pressure surges caused by lowering tools in viscous mud may cause lost circulation. Gas entrainment in the mud column, swabbing of the hole, and lost circulation are common causes of blowouts. The operator should plan a mud program designed to produce and maintain low viscosity, zero initial gel and low final gel strength mud in order to prevent these dangerous blowout conditions.

The drilling plan should list the special operations to be performed in the well by depths. All anticipated drillstem tests, logs, coring intervals and other special procedures should be described in the drilling plan. This information permits the contractor to be prepared to carry out these operations safely by having good hole and mud conditions at the time the operations are to be conducted. The drilling plan should present the anticipated completion procedure of the well. This procedure must be designed from a safety standpoint, and the contractor advised so that he can prepare for its execution.

The operator's responsibility does not end with the completion of the drilling plan and its delivery to the contractor. The operator must continue to improve his plan as new drilling data is obtained and should make available at all times a qualified representative who can consult with the contractor on steps in execution of this plan.

To insure safety in drilling and to protect his interests, the operator should make certain that the contractor adheres to the drilling plan. For the same reasons the operator should frequently inspect the contractor's drilling equipment during the drilling of the well.

Executing the Drilling Plan

It is understood that the contractor is solely responsible for performing the drilling plan. The contractor may obtain advice from the operator but he alone is responsible for the safe conduct of drilling operations. The contractor should prepare for the execution of a blowout preventing program by carefully training his drilling personnel and by properly designing, installing, and maintaining his drilling equipment.

Training the Drilling Crew

Safety in drilling operations and specifically in the prevention of blowouts comes from the training of drilling personnel. Combat veterans of the last war were impressed by the fact that trained troop units consistently had lower casualty rates under the same combat conditions than did poorly trained units. What is the military plan for the training of troops? It is extensive indoctrination and repetitive drilling, all aimed at teaching soldiers to act automatically under stress. Blowouts are emergencies, and the drilling crews should be trained to act accordingly. The drilling crew needs indoctrination in the causes and symptoms of blowouts and repetitive drills in the operation of blowout prevention equipment. This training should be continuous and every member of the crew should be trained to perform his role and that of the other crew members.

Naturally, the drilling crew should be required to maintain the rig equipment and follow good housekeeping practices. Likewise the crew, particularly the derrick man, should have thorough training, preferably a formal, short course, in the treatment of drilling muds. The treatment of the mud to maintain uniform mud properties is important in blowout prevention and is the crew's responsibility.

Training of the crew to maintain the rig and the mud program and perform other day to day operations is not a difficult task because all these operations are performed frequently and become routine. Because blowouts rarely occur, crew interest in a training program for blowout prevention is difficult to inspire. Hence, the contractor must continually emphasize training for blowout prevention and must have a good training plan. A training program should include:

1. A discussion of conditions which cause blowouts should include:
   a. Penetration of high pressure formations.
   b. Penetration of formation in which lost circulation occurs.
   c. Low density mud.
   d. Lightening of mud column due to gas cut mud, loss of returns, swabbing hole by tripping of drill pipe or other tools, and failure to keep the hole full.
2. Instructions on recognition of the indicators of an imminent blowout to include:
   a. Gas cut mud.
   b. Loss of returns.
   c. Excessive returns of mud.

d. Rapid acceleration of drilling rate.
e. Water flow.

3. And instruction in the operation of blowout preventer controls to include:
   a. Functioning of each preventer.
   b. Location and operation of controls.
   c. Operations of all sources of closing energy.
   d. Repetitive drills on blowout prevention to include: (1) closing of all blowout preventers, (2) killing of all engines, motors, and fires. An occasional drill should be made when the crew is not forewarned. Each member of the crew should be trained to perform the closing operations nearest his normal duty station and trained to perform the duties of each and every other member of the crew. This drill should be practiced until the crew can completely close the well within 90 seconds.

Drilling Equipment to Prevent Blowouts

The contractor is responsible for installing and maintaining a rig adequate for drilling the specific well. The use of well designed, well maintained equipment instills confidence and promotes discipline in the crew. While the general condition of the rig has a direct bearing on prevention of blowouts, the mud system and blowout preventer equipment are the most important parts of the rig used in preventing blowouts. Special warning and safety devices are also necessary.

Mud System

A good drilling mud is the primary preventative of blowouts, hence, the mud system should be designed to supply a good mud in large volumes to the hole. Factors in the design of a mud system should include:

1. Reserve mud storage to meet emergencies arising from lost circulation, loss of mud and gas entrainment. The necessary volume of reserve storage will, of course, vary with the depth and character of drilling.
2. Housed storage of mud materials convenient to mud mixing facilities. The amount of mud materials to be maintained is dictated by anticipated drilling conditions but should be more than ample for any emergency.
3. Mud mixing equipment designed for rapid mixing of large volumes of mud. For all wildcat drilling, a second slush pump is needed so that mud can be mixed and the hole circulated simultaneously. The second pump can be used as a standby pump, an essential in wildcat and deep well drilling.
4. Special devices such as a choking arrangement on the bleed off line, drill pipe protectors and so forth.

Blowout Preventer Equipment

Blowout preventer equipment is a secondary system of blowout control. Blowout preventers do not prevent blowouts. Their use is a stop gap measure to be employed while the mud column or primary blowout control is rebuilt. As a substitute for the mud column, the blowout preventer equipment should have similar characteristics to those of the mud column, that is, the blowout preventer equipment should:

1. Be automatically adjustable to close on any equipment that may be run in the hole.
2. Must be immediately available and completely effective for any anticipated emergency.
3. Must be closed by controls that are simple and easily operable so that the least motion, mental thought, and physical effort is required of the crew in closing the preventers.

The blowout preventer system to be wholly effective must be designed to perform the following functions:

1. Close on open-hole.
2. Close on any type of drillstem or any tool that might be run in the hole.
3. Close the opening within the drillstem or any other hollow tool that might be run in the hole.
4. Permit rebuilding of the mud column under pressure.
5. Permit movement of the drillstem under pressure.
6. Permit the installation of additional blowout preventer equipment for stripping or running the drillstem or any other tools.

Blowout Preventer Control System

The design of the controls for closing the blowout preventer equipment is as important as the design of the blowout preventer equipment. The following are fundamental requirements in the design of blowout preventer controls:

1. The controls must close the preventers swiftly. As noted earlier, a well should be closed in within 90 seconds. The writer believes that manual closing of blowout preventers is too slow for emergency conditions. In most areas of drilling hydraulic closing must be employed.
2. The closing controls must be simple in operation and clearly marked with operating instructions.
3. The controls must be located so that they can be quickly and safely reached. The blowout preventer system should have a dual set of controls—one on the rig floor and the other at a safe distance from the rig (not less than 75 ft away).
4. The controls must have more than one source of closing energy, particularly where the principal source may be dependent on the operation of a motor or engine. It is preferred that the closing system include a motor or engine driven hydraulic pump with an accumulator tank which contains at all times sufficient liquid under pressure to close all controls at least twice. Secondary closing equipment should include a manually operated hydraulic pump and cylinders of an inert gas under high pressure. All of these energy sources must be located in a place safe from destruction in the event of a blowout and/or fire. All energy sources must be connected to the controls with as little valving as is practical.

Warning and Safety Devices

Certain warning and safety devices should be installed on all rigs. A warning device considered essential is a float device to warn the crew of a sudden change in the level of the mud in the surface pits. The safety devices would all be designed to extinguish all sources of open flame in the event of blowout. A master switch which will instantly kill all engines should be installed at the blowout preventer control panel. A similar switch may also be installed at the remote blowout preventer control station. Boilers should be equipped so that steam can be flowed instantly into the firebox. All other open flame equipment should be equipped for rapid extinguishment.

Conclusions

In summary, most blowouts can be prevented by the execution of a safe drilling plan. Operators should assume the responsibility to prepare a safe drilling plan.

The contractor is responsible for the execution of the drilling plan. To carry out a safe drilling plan he must properly train his drilling crew and equip his drilling rig. The crew should be trained to understand the causes, recognize symptoms, and act with dispatch in preventing blowouts. The crew must be applied with adequate, quick acting blowout prevention equipment. These measures will prevent many blowouts. ★ ★ ★

Three Prominent Oil Men Discuss . . .

Automatic Custody Transfer Of Crude Oil

Completely automatic lease transfer and metering of crude oil is no longer a thing of the future — it's here! Unattended operation may now be considered economical for 50 bbl per day leases

H. C. Packard, *Shell Oil Company, New York, New York*
Harold S. Kelly, *Phillips Petroleum Company, Bartlesville, Oklahoma*
A. H. Newberg, *Service Pipe Line Company, Tulsa, Oklahoma*

PART 1: GENERAL CONSIDERATIONS

H. C. Packard*

"CHANGING Times" might be a much more apt title in describing current production trends. Certainly, methods are changing in measurement of crude oil. Many resulting benefits are being realized, and just ahead there are more to come.

Until very recently, manual gaging, sampling, and testing of lease tanks have varied mostly in detail improvements to otherwise generally accepted and retained ideas. This has been the case rather than any real changes in basic concept or design. This has presented somewhat of an anomaly, the work in question being as it is an inherent part of the otherwise highly dynamic and outstandingly progressive petroleum industry.

In recent years, a considerable change in thinking has developed. With automation developing at a rapid pace in other fields, the oil producers recognized that the methods of handling crude oil needed critical review and modernization. Developments in this respect now are gathering momentum, particularly in measurement.

Various factors have contributed to focusing attention on the realistic need for regarding measurement in a much more important light. This increased recognition currently stems primarily from two causes. First, using measurement in itself as a more efficient means for operational controls; and second, the realization of potential economic advantages and reliability in measuring operations. Underlying all of this is our share of the national ethical obligation to prevent waste of our natural resources, so that conservation of our petroleum resources is an objective for all of us.

Editor's Note: Top three men on the American Petroleum Institute's Committee on Crude-Oil Measurements have collaborated to present this complete survey of recent developments in automatic custody transfer. This team presented its findings before a group session of the Division of Production during the thirty-sixth annual meeting of the API, in Chicago, Illinois, November 13, 1956.

General

Interest centers primarily on the most recent equipment developments, that of automatic custody transfer of crude oil. The industry frequently refers to this simply as "Lease Automatic Custody Transfer" or "LACT" for short. This development may be defined as consisting of equipment and procedures whereby the measuring of quantity and quality and the running of crude oil from the producers' leases to the connected pipe line is accomplished on a completely automatic and therefore unattended basic and all in accordance with any predetermined schedules required and applicable regulations.

It is not the purpose to provide detailed technical descriptions of LACT systems, as such information is available in comprehensive form in the just-published API Bull. 2509A. Such systems generally may be classed broadly as either (1) volumetric chamber measuring, or (2) meter measuring. The former may be in various tank-

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number and tank-type combinations. While the latter may be either a wholly automatic system or one only partially so. A summary of currently known installations by company, location, and type is given in Table 1.

Each system must include "fail-safe" features to provide assurance against mismeasurement due to all reasonably forecastable causes. Each also must provide the quality monitoring required to prevent running non-merchantable oil into the pipe line. Time and quantity operating controls must be included to provide for such matters as compliance with production regulations and ability of pipe line to receive.

Systems also are designed for desirable sequential integration with the considerable other automatic equipment already available for normal lease operations, such as lifting, separation, treating, and production testing. This LACT development then simply becomes the "end of the line," rounding out a cycle of completely automatic lease operation.

Costs vary with type of system, and may run to a few thousand dollars; but being justified in savings in other investment, operating expense, and conservation. In any case, for leases justifying such installations, the advantages are manifold and are shared by various parties concerned in the custody transfer. Also, present system costs may be much reduced by whatever improvements and simplification can be jointly developed by industry and manufacturer-suppliers.

Historically, development of LACT systems has been done largely by producers. The primary reason for this is that the tanks in which measurement has been made for so long have, by tradition, been purchased and installed by the producer. Nevertheless, pipe line companies have shown a great deal of interest and have been very influential in design of all types of LACT systems, particularly recently for the meter measuring types. Industry-wide exchange of information, ideas, and design and test data has been accomplished largely through the LACT special-project function of the API Committee on Crude-Oil Measurements. Actual design, installation, and testing of specific equipment have, of course, been done by individual companies.

Measurement Accuracy

Properly designed and maintained LACT equipment may be expected to consistently measure at least as accurately as hand methods at their best.

Two characteristically inherent advantages of instrument-controlled vs manual operations are:

Reduced error possibility in both measurement and calculations.

Simplification of computation and accounting procedures.

Oil Conservation

Reduced number of tanks decreases exposure to evaporation losses. This improves the quantity position as well as retaining a higher gravity — both a potential gain in dollar value.

Reduced opening of tanks, such as in manual gaging, also achieves similar results, as does the reduction in storage time of oil in tanks awaiting being run.

Controlled oil-run timing permits closer evening out of casinghead gas for processing thereby reducing flaring, also leading to quantity and quality improvement. These timing controls also permit much greater efficiency in use of the considerable capital already invested in gasoline-plant equipment.

Safety

Such systems contribute greatly to improved safety, particularly as to personnel, equipment used, and oil handled.

Tighter Timing/Quantity Controls

Scheduling runs on a predetermined basis, making them at the most opportune time, takes full advantage of round-the-clock operations in all types of weather.

Much of the automatic equipment already installed in production operations can be utilized in LACT systems. At least one company has developed such a design that capitalizes on its present automatic tank switchers in use on a number of its leases and will require only a nominal amount of additional gear to achieve LACT.

LACT provides automatically for the end phase of, and thus improves, compliance with production-allowable regulations as to both timing and quantity.

Steel Conservation

Both tankage and metering types of systems offer significant possibilities for

TABLE 1. Lease automatic custody transfer installations in operation November, 1956.

Producer	Location	Pipe line	Basic volume measurement by	Date of first installation	Automatic custody transfer begun
Stanolind O & G	Duncan, Oklahoma	Service PL.	Tank	April 1956	
Texaco Expl.	Bonnie Glen, Alta.		Two systems Tank and meter	April 1956	
Texas Co.	Wilson Creek, Colorado	Utah O. & R. Co.	Meter	Early 1954	
Texas Co.	W. Cote Blanche, La.	Texas PL.	Tank	1956	Approved February 1956
Texas Co.	Naval Reserves, Oklahoma	Mid-Continent	Tank	September 1956	
Gulf Oil Corp.	Bloomer, Kansas	Kaw PL.	Tank	December 1955 (1)	December 1955
Western Gulf	Yorba Linda, California	Union Oil Co.	Meter	September 1956	
Gulf Oil Corp.	No. Ward Estes, Texas	Gulf	Tank	Under construction	
Imperial Oil Co.	Redwater, Alta.	Imperial PL.	Meter	October 1955	November 1955
Imperial Oil Co.	Excelsior Batt 1	Imperial PL.	Meter	September 1956	September 1956
Imperial Oil Co.	Excelsior Batt 2	Imperial PL.	Meter	November 1956	September 1956
Shell Oil Co.	Antelope, Texas	Sinclair PL.	Tank	February 1948(2)	Approved, test started October 1, 1956
Shell Oil Co.	Wasson, Texas (3)	Shell PL.	Two systems Tank and meter	July 1953 (3)	
Shell Oil Co.	East Texas	Shell PL.	Two systems Tank and meter	August 1956 (3)	
Shell Oil Co.	Brea, Calif. Mechego	Shell Oil	Meter	May 1956	Late 1956
Shell Oil Co.	Brea, Calif. West Puente	Shell Oil	Meter	July 1956	Late 1956
Phillips Petroleum	Panhandle, Texas (Ranch "C" Lse.)	Phillips PL.	Tank	1956	Approved September 1956
Phillips Petroleum	No. Burbank, Oklahoma	Phillips and Mid-Cont. PL.	Tank	August 1956	September 1956
Phillips Petroleum	Basal, Oklahoma	Service PL.	Tank	Under construction	
Sinclair	Wertz Dome, Wyoming	Sinclair PL.	Meter		
British America			Meter		
	OTHER INSTALLATIONS NOT PLANNED FOR COMPLETELY UNATTENDED OPERATION				
Humble Oil	Anahuac, Texas	Humble PL.	Meter	1954	Hearing August 1956
Humble Oil	Friendswood, Texas	Humble PL.	Meter	1954	
Humble Oil	Conroe, Texas	Humble PL.	Meter	1954	

(1) Originally installed Glenn pool, Oklahoma, early 1954
(2) Revised over several years.
(3) Have 25 tank-measurement batteries equipped for immediate conversion to ACT on approval in Wasson and Harper fields, Texas.
(4) Revised over several years.
(5) Original installation 1952. Revised over several years.

reduced tankage, either as to number or size, and possibly both. This arises from several causes, principally among which are:

1. Instrument controls permit more frequent or regular runs, reducing quantity-storage requirement.
2. Meters or small specifically designed measuring tanks reduce normal tank type and size requirements in this respect.

Steel savings in the given case result from studying all the attendant circumstances. Single-battery reductions, however, may be typified by the steel needed in a 100 or a 1000-bbl tank, and so on. Generally, the concept of storage needed has been the equivalent of at least three days' production.

As a future possibility, it may be that the precision yielded by automatic instrument controls will permit:

1. Successive use of a given LACT tank system for oils of varying ownership interests, thus eliminating need for adjacent separate batteries.
2. By limiting quantity and quality instrumentation preceding the tank system, perhaps even actual simultaneous intermingling of oils of varying ownership interests in a given LACT tank system.

In any case, LACT systems offer possibilities for conservation in still another valuable natural resource.

Gathering System Factors

Possibilities of more constant load factors should permit reductions in pumping power and line sizes for new systems at the design stage. For established gathering system lines, this is questionable to the extent that present lines could not economically be removed for replacement by smaller lines. On the other hand, established lines might to some degree handle more oil if introduced primarily from newly installed or converted time and quantity controlled LACT systems. Also, pump motors might be reduced in size if oil could enter the line timed when the system pressure is at a minimum.

Greater efficiency may be achieved in the planned integration of production allowable needing to be run with pipe line ability to handle. This should yield advantages to both parties in facilities and manpower utilization.

Operations are possible on a 24-hour-a-day basis in all types of weather.

Manpower Utilization

Pumper and gager transportation costs and time in turning tanks on and off the line and in making measurements will be reduced.

On the other hand, instrumentation for automatic operations sets up a more complex system. This requires additional and more costly employee skills for design and installation, for inspection, maintenance, and calibration. Inasmuch as these skills will be required at each installation periodically rather than continuously, however, more efficient utilization of appropriate personnel within an operating area should be realized through the elimination of some scheduled but unused operational time. Preventive maintenance, always desirable, is likely to be improved because of the increased skills employed.

Upgrading an operation is in tune with our times. Reduction of routine and manual tasks coupled with upgrading of personnel, where feasible, to provide the more complex skills required, is in keeping with the more effective utilization of existing manpower in an expanding economy.

Streamlined Accounting

Presentations elsewhere have ably described the considerable and progressive strides already taken in adapting time-consuming detail procedures of accounting to electronic handling with both accuracy and dispatch. LACT systems permit further integration with machine-accounting procedures. Additionally, systems providing for summary recording of several successive oil runs from a given installation may reduce individual run-ticket requirements and handling by as much as 90 per cent.

Instrument transcription of measurement results and identification of oil runs eventually should provide means utilizing transmission by teletype or code via microwave or other methods to data-processing locations, for integration there with these modern accounting methods. The possibilities certainly seem attractive, and at least one company is now equipping one of its leases to function on such a completely integrated system.

Current Acceptance

Do such systems merit acceptance?

The first answer is yes — from both production-operational and technical-design standpoints. The operational aspects have already been discussed and the technical aspects may be summarized as simply these two basic requirements for the oil run: The first is determination of quantity, temperature, API gravity, and suspended bs&w content, the same as in manual operations; the second is monitoring protection to assure none but merchantable oil entering the pipe line, and mechanical design to assure fail-safe operation. For the most part, LACT system components each are well-known and recognized as reliable in other applications. Therefore, the newness aspect consists only of the devising of the system itself, into which these components are fitted and combined for this particular new application. Of course, as for any other newly devised system, trial operation is needed in order to eliminate any "bugs" found. With careful planning, adherence to recommended principles, inspection, and consultation between interested parties in given cases, there need be little or no fear of foreseeable failure.

The second answer also is yes — this time from the standpoint of compliance with normal purchaser and pipe line specifications. Provision is made for the same basic measurement requirements as heretofore, and the monitoring and fail-safe features are insurance against running "bad oil" and mismeasurement. The combined timing and quantity controls provide protection against departures from proration regulations where applicable. Our API Committee on Crude-Oil Measurements has been very active on behalf of this viewpoint particularly, by insuring full, objective, and current consideration of this development. This group also provided the original forum for such consideration. Sufficient experience has not yet been gained for us to standardize any one or more systems, but our methods for handling stimulate and encourage further developments and their proving by experience.

A third answer is concerned with the economics of such a system. The discussion so far has summarized certain net advantages to be anticipated, mostly those gained once such a system is in operation. But investment of capital is required to make the installation. This requires the same weighing of economic and practical factors as for any other capital expenditure in the potential payout category. In addition to the usual straight economics, LACT systems appear to have several intangible but nevertheless plus values. So our third answer is that the matter still is in evolution, and that, as the number of developments or installations increases, costs well may be reduced; installation of such a system is merited where the net of all practical and economic projections will justify it.

Now a fourth answer involves overall acceptance by the parties concerned with buying or running the oil. To the company that has justified the making of such an installation, such justification is not complete until mutually ac-

cepted by all concerned, preferably at the planning stage. After all, even though to be expressed as a hope for the future, a blanket acceptance at this stage is not to be expected. In any case, evaluation by each party is only a minimum "fair shake"; however, it is anticipated that each case will be presented so as to merit, and will receive, the enlightened consideration now consistent with our progressive industry.

The fifth and probably last general question of acceptance will be that of the attitude of the applicable regulatory authorities. Will they accord recognition and acceptance? Only they can answer this. If each applicant for authorization has properly designed his system, taking into account the recommendations made from our successful experience already gained with such systems, it appears that the attitude of the boards and commissions will be receptive. We have some precedents of record to sustain this line of thinking.

1. The Alberta Petroleum and Natural Gas Conservation Board, on November 15, 1955, granted permission to Imperial Oil Company and Imperial Pipeline Company for six-months trial, on an automatic basis, of a meter-type system in Redwater field.

2. The Louisiana Department of Conservation, in February, 1956, granted permission to The Texas Company for three-months trial, with checking by conventional measurements, of their tandem tank-type automatic battery No. 4 in the West Cote Blanche field.

3. The Texas Railroad Commission, on August 22, 1956, granted permission to Phillips Petroleum Company and Phillips Pipe Line Company for six-months trial, on an automatic basis, of Phillips' tank-type system on the Ranch "C" lease in the Panhandle field.

4. The Texas Railroad Commission, on August 22, 1956, granted permission to Shell Oil Company and Sinclair Pipe Line Company for six-months trial, on an automatic basis, of Shell's two-tank measuring system with weirs on the Hugh Henderson lease in the Antelope field.

5. The Oklahoma Corporation Commission, on April 12, 1956, approved LACT at North Burbank. The U. S. Department of Interior and the Osage Indian Agency, on April 5, 1956, also approved this installation. The Oklahoma Corporation Commission at the same time also approved an LACT battery for a lease in southern Oklahoma.

Conclusion

Definite net advantages have been shown as potentially accruing to producers, pipe lines, and others. Some of these advantages already are being achieved or are available in existing fields. LACT systems in new producing fields, however, with newly designed and installed gathering systems, should offer considerably greater potential savings to all parties concerned in the custody transfer.

Some pros and cons applicable to those concerned have been discussed, as seen from a general viewpoint. Some further and more specific ideas on the matter as seen from within the two respective operating interests now most concerned are presented in Parts 2 and 3. ★ ★ ★

PART 2: FROM THE PRODUCER'S VIEWPOINT

Harold S. Kelly*

The various divisions of the petroleum industry are each well aware of their part in the petroleum industry's overall objective of providing the consumer with desired top-quality finished petroleum products at minimum cost. Members of the producing division continuously strive to perform their part in the overall objective in an efficient and economical manner. Automatic custody transfer, therefore, is attractive to the producer because it offers improvements over manual testing and gaging in stock tanks.

The more significant advantages of lease automatic custody transfer to the producer can be placed in three major categories: (1) Lower initial investment; (2) Better and safer utilization of manpower and reduction in monotonous detail, and (3) Increased conservation of natural resources.

Lower Initial Investment

For any typical lease with roughly 100 bbl per day or more production, the initial investment for an LACT battery is less than for an equivalent typical manually operated lease-tank battery. The automatic battery requires the same treaters and settling tanks and settling as does the manual battery. Standby storage for accumulation of possibly a day's production is sometimes required in the LACT battery to take care of emergency shutdowns. The major investment savings are the result of the lesser cost of small metering tanks or positive displacement meters and attendant instrumentation that take the place of the usual storage tanks. It is obvious that the greater savings in investment will be on the batteries handling the larger volumes of oil; but even on relatively small batteries, LACT requires less investment. Although required investment in LACT batteries will decrease further as designs are simplified and standardized, the investment figures portrayed by Fig. 1 are roughly representative of current costs. This figure shows the investment savings presently possible on various sizes of batteries. For example, on a 500 bbl per day lease, the investment saving would be $2000, whereas it would be $75,000 on a 5000 bbl per day lease.

The investment advantage which the

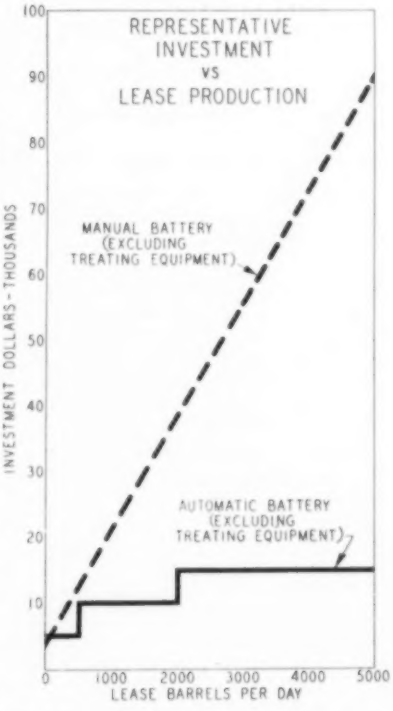


FIG. 1. **Investment costs** decrease proportionately for larger lease systems. Major investment savings are the result of lesser cost of small metering tanks or positive displacement meters and instruments that take the place of storage tanks.

*Phillips Petroleum Company, Bartlesville, Oklahoma, vice chairman, API Committee on Crude-Oil Measurements.

LACT battery has for the larger volumes makes it attractive for tank-battery consolidations. In the past, manual tank-battery consolidations have been effected on unit operations, large leases, or on adjacent leases having common royalty ownership. With present metering and sampling facilities, it is possible to meter and sample the production on separate small leases and then transport the production by lease lines to a central consolidated battery where treating and sale of oil can be handled with a minimum of investment and less operator time. Another alternative is the metering, storing, and sampling on small leases and then running, at a regular scheduled time, the individual lease production to a central battery for treating and custody transfer to the pipe line. The central battery, by automatic scheduling, could alternately handle production from different leases with different ownership.

Better and Safer Utilization

The amount of operating personnel required for a given lease is influenced by the particular characteristics of the leases and wells, the type of artificial lift, the lease equipment including the tank battery, and the operating policies of the producer. The number of steps and time required to carry out the various phases of the typical lease-operating job have been approximated through method studies. On the basis of these studies it has been concluded that LACT battery operating costs will be roughly $1200 per year less than those for each manual battery that the pumper handles where one or more tanks of oil are run daily from each battery. These figures are based upon the switcher or pumper being required to meet the gager to witness the gaging of tanks. This operating saving is cut in half where the producer has already worked out an arrangement for sale of oil by an exchange of gage information on written forms deposited in a box at the battery without the requirement that the switcher or pumper witness the gaging and testing of each tank by the gager. Further, these savings can be actually realized only where there is a sufficient concentration of wells and

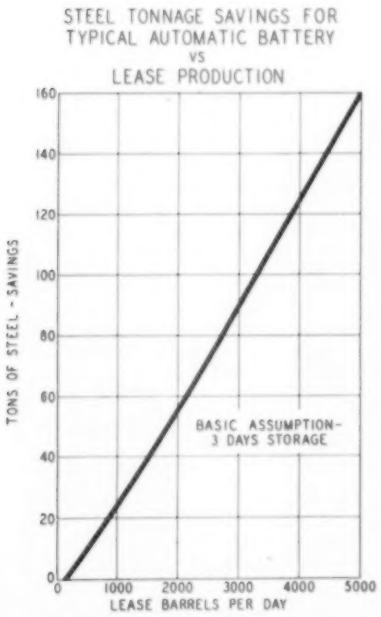
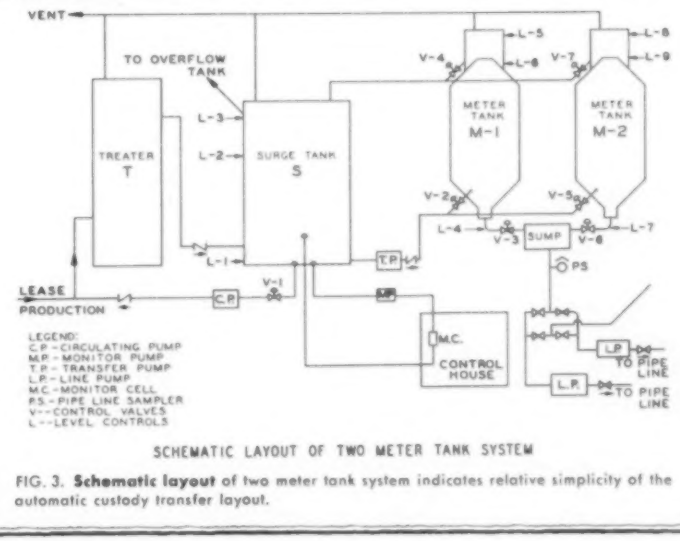


FIG. 2. **Steel tonnage savings** for typical automatic battery as compared with lease production provide additional conservation basis.



SCHEMATIC LAYOUT OF TWO METER TANK SYSTEM

FIG. 3. **Schematic layout** of two meter tank system indicates relative simplicity of the automatic custody transfer layout.

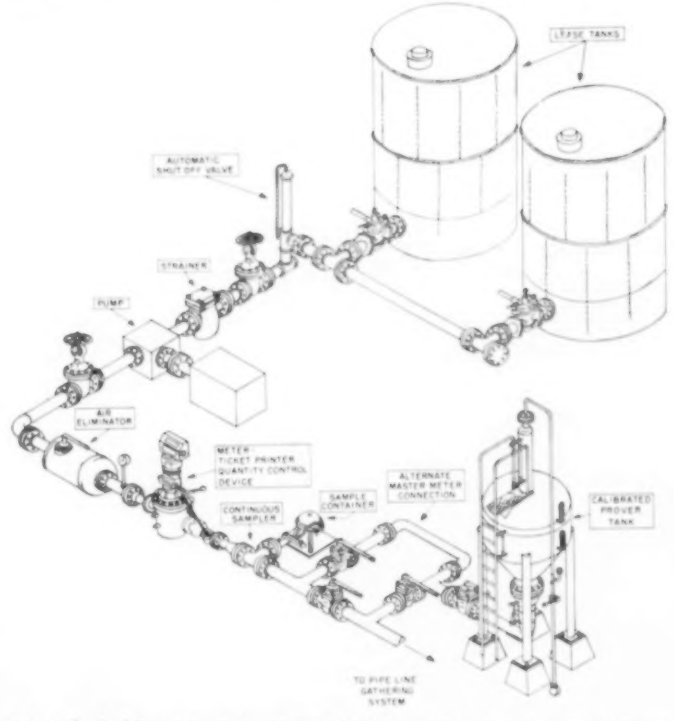


FIG. 4. **Typical lease metering** installation indicates only two lease tanks in use. Two 500-bbl tanks and the LACT battery can send 5000 bbl of crude to the line per day.

leases to permit profitable re-distribution of the operator's time.

LACT is the last major phase of complete automation of leases and, therefore, permits more effective utilization of lease operating personnel. Prior to this, the maximum operating benefits from consolidation of manual batteries, automatic well testing, sampling, gaging, and switching were not always realized because manual custody transfer required operating personnel to be present at the battery at various times for gaging, testing, and transfer of production.

Service and maintenance of automatic-control equipment requires a certain amount of time of the skilled technician. Through regular checks and preventive maintenance, however, the amount of technician time can be held to a minimum and effectively spread over a broad operation.

LACT battery eliminates the hazards involved in the pumper and gager climbing the stairs and manually gaging and thiefing at the open thief hatch. Where hydrogen sulfide exists in the produced gas, the manual gaging operation is particularly hazardous. Further, the monotony and physical effort of frequent manual gages and recording of them are eliminated by the LACT system.

FIG. 5. **Lease meter** installation is in the Anahuac field, South Texas. The installation was made by Humble Oil & Refining Company in 1954.

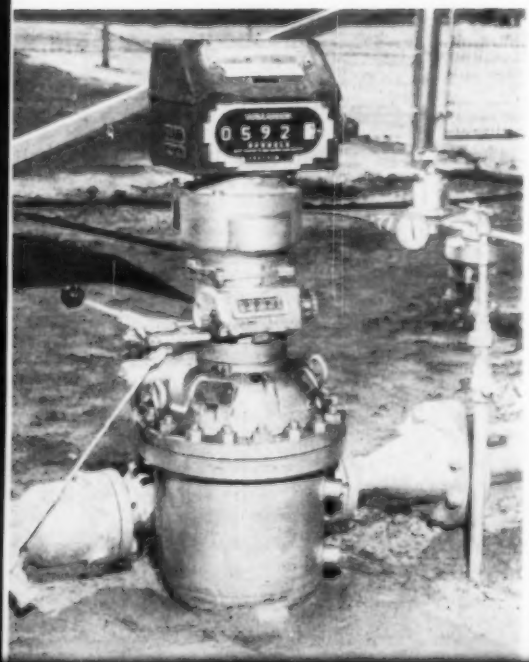


FIG. 6. **Meter** here has ticket printer and quantity control device, sending crude on to the continuous sampler, out of the picture on the left.

Increased Conservation

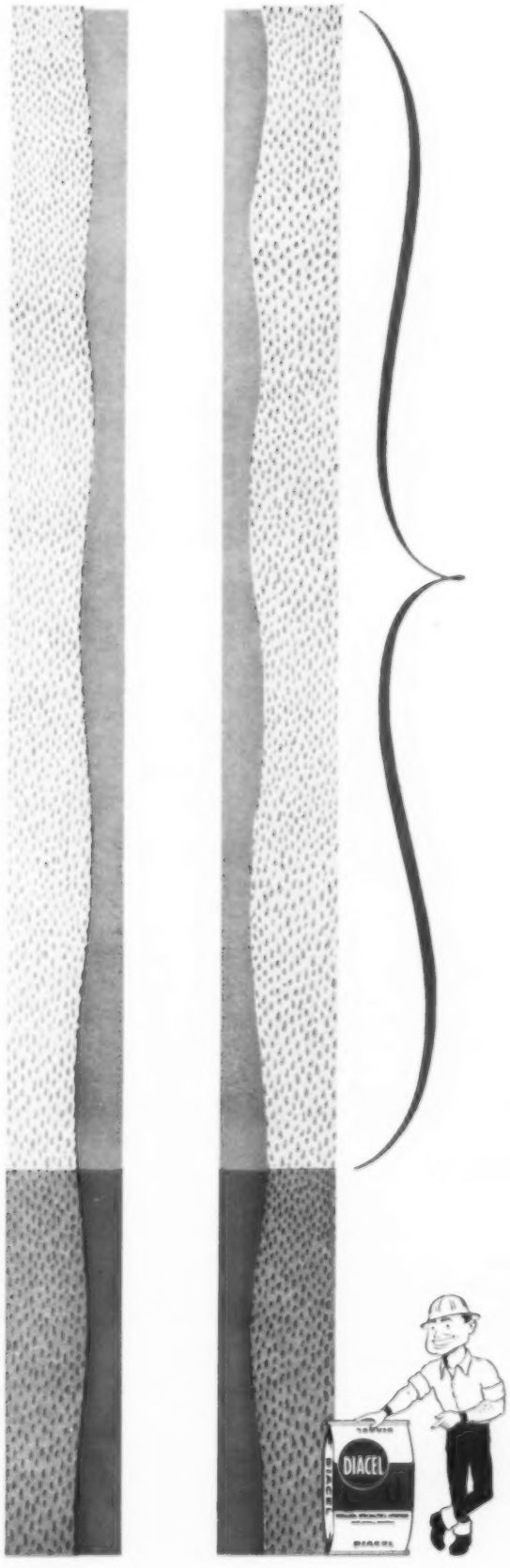
Lease automatic custody transfer contributes to conservation by a reduction in the loss of the lighter hydrocarbons. When compared with conventional lease storage the LACT battery offers (a) smaller area of oil surface exposed to the vapor phase, (b) shorter weathering time, and (c) elimination of opening the storage tanks to the atmosphere. Draw-offs for high bottoms are also eliminated.

Tests taken on full-scale trial LACT batteries operating in West Texas and Northeastern Oklahoma at pressures of roughly atmospheric to two ounces, which were equal to the manual battery storage pressures, show a minimum of 0.2 deg gravity increase on 38 to 40 API gravity oil. A rough rule of thumb is 2½ per cent volume increase for each degree increase. Therefore, 0.2 deg increase represents 0.5 per cent volume increase which is five barrels added to every 1000 bbl. Further tests operating the LACT batteries at the slightly elevated back pressure of only four ounces as compared with the previously mentioned atmospheric manual battery, showed increases from 0.6 deg to 1.4 deg in API gravity.

Lease automatic custody transfer batteries could easily deliver oil to the pipe line at a pressure of 25 psig, however, with present gathering systems and storage facilities, most transporters and refiners could not retain the lighter hydrocarbons in the oil delivered to them at this pressure. Gasoline plants recover and conserve these lighter fractions for leases connected to them; however, for unconnected leases an increase in delivery pressure to the pipe line could mean a significant increase in the volume conserved and sold by the producer. As LACT batteries come into widespread use, there may be economic justification for pipe line systems and refineries of the future to be designed to handle crude at elevated pressures.

An indirect contribution to conservation results from the lease automatic custody transfer battery adding to the economic justification for overall lease automation, which includes equipment to automatically schedule and test individual wells on a multiple-well lease. Better well-test data will enable the operator and the reservoir engineer to make reservoir studies and carry on workovers and operations more effectively with a resultant higher percentage recovery of the hydrocarbons in place in the reservoir.

Another indirect contribution to conservation of natural resources is in the reduced consumption of steel. Fig. 2 shows roughly the steel-tonnage sav-



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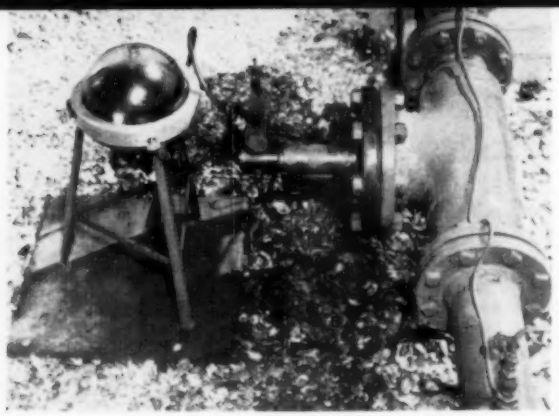

FIG. 7. **Continuous sampling** device with sample container. This unit takes a sample of oil to obtain gravity and bs&w content.

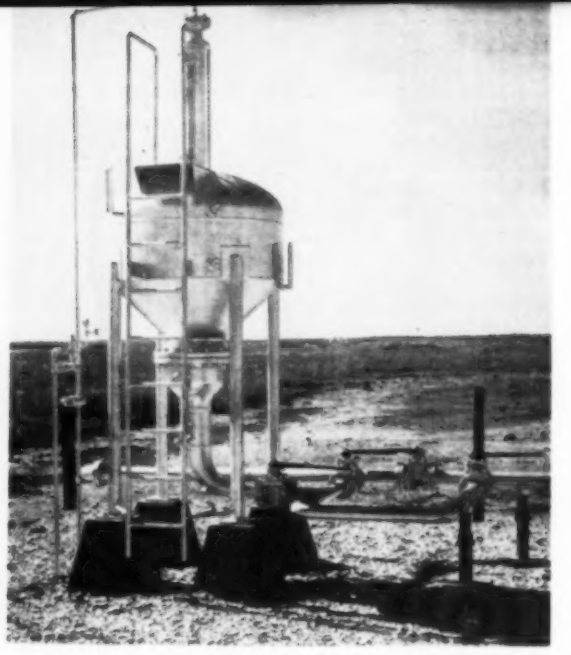

FIG. 8. **Meter prover tank** is an installation made in Webster field of Harris County, Texas.

ings for various sizes of typical batteries when lease automatic custody transfer is used. For example, 160 tons can be saved on one 5000 bbl per day battery.

Summary

On the basis of present equipment development and limited operating experience, one may conclude that LACT batteries can be justified from the standpoint of investment alone, for volumes of 100 bbl of oil per day or larger.

When all factors favorable to the LACT battery, from the producers' viewpoint, are taken into consideration, it may be possible to justify use of the LACT system on leases producing as little as 50 bbl of oil per day. This conclusion is based on the following approximate figures for a 50 bbl per day battery:

	Manual Battery	LACT Battery
Initial Investment (Manual battery includes two 90-bbl storage tanks. LACT battery includes two calibrated metering dump tanks and capacitance cell monitor.)	$3800	$5000
Yearly Labor Savings		300
Value of Yearly Volume Saved ((50 bbl per day) (365 days) (0.005 vol. loss) (⅞ net) ($2.65 per bbl) = $211)		200
Time required to pay out difference in investment		2.4 years
Return on $1200 added investment for 15-year life		41 per cent

Since the savings used in the foregoing example are conservative, the per cent return realized for the added investment for a 50 bbl per day LACT system may be higher than the 41 per cent shown. In addition, the same LACT battery can handle as much as 450 bbl per day increase in production that may be occasioned through the drilling of additional wells or consolidation with other leases.

Acknowledgments

Acknowledgment and sincere appreciation are given to the production departments that permitted exhibits of some of their LACT batteries and equipment to be included in this paper; or permitted color pictures to be taken for the verbal presentation. These companies include Phillips Petroleum Company, Humble Oil and Refining Company, Gulf Oil Corporation, Shell Oil Company, Stanolind Oil and Gas Company, and Monterey Oil Company. ★

PART 3: FROM THE PIPELINER'S VIEWPOINT

A. H. Newberg*

When viewing progress made by the industry, particularly those operational phases that have advanced toward automation, the question may well be asked, and in fact is being asked by a large section of oil-industry management, "Why have crude-oil measurement methods resisted basic revision?" This can probably be answered best in the words of R. A. Hamill. He gave two fundamental reasons: "1. The custody transfer of oil is tantamount to the custody transfer of money. 2. Experiments to date with some of the instruments developed to make gaging automatic have been disappointing."

The pipeliner, as regards oil-measurement practices, cannot take the position of representing only one branch of industry operation, that of transportation. His company basically does not own any oil, and yet its responsibility involves the wearing of two representative hats: One that of the shippers' agent, and the other that of the pipe line transporter. Although the necessary checks and balances are always available to assure buyer and seller getting value received, the pipeliner, being in the middle in performing the routine measuring, sampling, and testing functions, must take a conservative viewpoint when any significant revisions in practices are considered.

It is interesting to recall that the industry's first effort to reduce gaging to

*Service Pipe Line Company, Tulsa, Oklahoma; secretary, API Committee on Crude-Oil Measurements.

an automatic basis has been largely directed toward transfers at delivery terminals. Although many reasons for such efforts are obvious, it seems basically wrong to expend more effort at this end than at the field end. If there is any place where the necessary manpower can be afforded to supervise the transfer of oil, it is at terminals where the volumes are usually large and the increments for supervision small as compared to similar transactions at the lease-tank level. Therefore, the possibilities of effecting improved measurement, oil conservation, and economic savings appear much greater at the lease tank.

Experience reported during this past year with several lease automatic custody transfer systems, some of which have been under test for two years or longer and have very recently been approved for a trial period in actual custody transfer use by several state regulatory bodies, is providing good reason for the pipeliner to have renewed confidence in accepting such systems. Although still taking a conservative position of keeping our feet firmly grounded in the realities of the present, we pipeliners are beginning to realize that all new developments need not be directly compared to present methods in order to conform to accepted standards. With many new systems, devices, and techniques tested under field conditions, it is now possible to economically and practically obtain measurement accuracy at least as good as with present manual methods.

It is expected that each pipe line company will consider LACT proposals individually, and acceptance of each proposal should be based on a critical analysis of the design and operating features, particularly as regards their ability to control pipe line lease runs where regulations require; assurance that the oil is merchantable before it is run; and assurance that the control and recording system is fail-safe against mis-measurement.

Recent Developments

As expressed in Part 1, development of LACT systems to date has been primarily initiated and designed by the producer; but the pipe lines, primarily through active representation on the API special committee, have contributed ideas and been willing to engage in joint testing operations which have had considerable influence on the actual design and types of installation. This initiative by the producer is understandable, considering the great strides made in automatic production methods back of the lease tank itself. Since loss control is of major benefit to the producer and related interests, such initiative should provide a better understanding and a more clear-cut separation of the problems dealing with losses as against those dealing with accurate measurement.

It is true that automatically operated lease tanks will not be economical for all United States production run by pipe lines. A study made of leases connected by one pipe line in the Mid-Continent area, including North, West-Central, and West Texas, plus New Mexico, Wyoming, and North Dakota, shows that for August, 1956, only five per cent of the leases ran more than 200 bbl per day, however, this represents approximately 47 per cent of total oil run from all leases. Even considering the limited scope of the study, I believe a conservative estimate would be that within 10 years, as much as 25 per cent of the total oil gathered by pipe lines will be handled under LACT methods. Improvement of the art and standardization of LACT systems during this period should permit their economic application to leases handling considerably less than 200 bbl per day.

Where existing lease installations are converted for automatic custody transfer, some immediate savings will accrue to the pipeliner. With ability to maintain more constant load factors on significant portions of gathering systems, savings in horsepower requirements, and thus a reduction in pipe line pumping-unit sizes, is possible. More continuous pipe line pump operations under more constant load conditions should also reduce maintenance cost. Existing gathering systems, originally designed for handling manual lease runs, will have greater usable capacity for handling increased production within certain sections. During extreme weather conditions, the costly and troublesome operations, delays, and even shutdowns that occur with manual batteries should be minimized with LACT. Probably the most significant savings will be the elimination or reduction of evaporation from the lease measuring vessel during the time oil is entering the pipe line. This will most certainly be true for small dump-tank systems that are operated under pressure and require only short periods for filling and emptying, in which case the quantity actually received by the pipe line will more nearly equal the measured quantity than it does today with standard lease tanks and manually controlled runs. This also permits increased oil conservation. The following intangible benefits will also accrue:

1. A reduction in human errors both in tests and measurements.
2. Elimination of many disagreements between pumper and gager (thus improvement in human relations). This also should result in closer conformance with important legal and company policy factors by eliminating human tendency on the part of pumper and gager to adjust mismeasurements.
3. Reduction of recording errors.
4. Elimination of high tank bottoms.

It may well be that during the transitional period, pipe line investment will be necessary at individual leases with no significant offsetting operating-cost savings. Each case will depend upon operating conditions, lease location, and other related factors. Such nominal investments can be justified, however, if they are the first step toward eventual LACT application at all or several leases within an operating area.

As acceptance of LACT systems increases, considerable investment and operating-cost savings should be possible in initially installed gathering systems. Line sizes can be smaller, thus conserving steel. Fewer tank connections are certain; and it may be that fewer lease connections will be necessary if we accept the statement that a LACT battery may replace more than one manually operated battery as considered today. In some instances it is entirely feasible that the custody transfer automatic-measuring facilities installed on one lease could be used on an alternate programmed basis to measure runs from several adjoining leases. This would reduce tankage required on such leases, increase the volume handled through the automatic facilities, and reduce the number of separate lease locations visited by the gager.

As regards lines and pumping units, size of both may decrease; but it is not yet clear whether a greater number of pumping units will be required. This is an area of conjecture depending upon what assumptions are made regarding operations, and also upon the agreed practical division of ownership of facilities between pipeliner and producer. There is the possibility of a necessary change in concept as to what constitutes the gathering service, not only because of the pumping question and the possibility of making measurements and custody transfer at fewer leases, but also because of the change in total manpower requirements for operating leases and gathering systems and inspecting and maintaining LACT systems and related facilities at the batteries themselves. This leads to the next major consideration.

Manpower Utilization

Considering the incremental saving

in pumper and gager time required at each lease with LACT, we can multiply this by the number of leases so operated in a given area and realize the profitability of expanding the amount of work that can be adequately supervised by such personnel. Progressive companies should begin planning now by providing opportunities for training their best pumper and gager personnel. This would involve calling their attention to the work of the API committee and the many articles dealing with experience and new development and such facilities. On a selective basis such personnel should be afforded specialized technician training in understanding basic characteristics of applicable instruments, controls, and measuring devices. Better understanding by both labor and management will result through such planning and abrupt personnel disturbance can be avoided. With such realization, I believe that during the interim, many otherwise normal full-time assignments of gagers can be avoided by use of relief personnel and permit attrition and upgrading to technician assignments to reduce the personnel now classified as pumpers or gagers. Reducing or eliminating the regular requirement for personnel to climb tanks certainly eliminates many hazards. This is particularly true in sour-crude areas. Elimination of monotonous routine and substitution of challenging assignments involving greater mental skill and dexterity should increase the sense of responsibility in the job performed and assure constant vigilance in protecting the interests of the buyer, seller, and transporter.

Comparative Standards and Acceptable Systems

Any system proposed must accurately measure gross quantity, include instrumentation that accurately permits determination of those conditions and properties affecting quality and net quantity, and also monitor to prevent non-merchantable oil entering the pipe line. A completely fail-safe system must be provided; that is, failure of any one control or major device must cause a complete shutoff of oil entering the pipe line. Restarting a system after corrections are made must be at the exact same point where shutoff occurred in order for no mismeasurement to occur. Such standards are believed possible and practical, and are actually more rigid than are possible with manual methods. Properly installed and maintained instruments and devices available today can provide better "repeatability" and record properties and conditions at time of measurement that can be obtained manually.

Bs&w monitoring devices have been proved accurate under continuous field service conditions. Such monitoring as oil is produced into the lease tank assures only merchantable oil being delivered and retained in the measuring tank for acceptance by the pipe line. The periodic centrifuge testing of the representative sample taken from all runs will provide the proper deduction for bs&w. What types of systems are likely to receive acceptance? The calibrated metering dump-tank system, consisting either of a converted lease tank or smaller vessel specifically designed for automatic operation, appears most promising for earliest major acceptance as evidenced by applications to date. It offers the best approach to checking results against manual methods at any selected time. Many improvements and simplifications have been and are now being made in such systems as compared to those reported in the recently published API Bull. 2509-A. One of the major questions involved in such systems is where the division of responsibility for providing certain measuring and sampling instruments, controls, and monitoring devices should be made for the producer and pipeliner. Experience will eventually evolve the answer.

For many reasons, not the least of which is the prospect of eliminating errors caused by encrustations built up on the tank shell, positive-displacement meters are receiving greater attention. Quoting from the minutes of the August meeting of the API committee on LACT, "It was generally agreed that the trend toward use of positive displacement meters is given force by:

1. The very good results reported so far from installations that have been properly made and maintained,
2. The prospect of elimination of encrustation errors,
3. The low cost of a meter installation,
4. The prospect that close control over measurement accuracy can be retained by the pipe line company, and
5. The ease with which the cost of such an installation can be properly allocated between the producing and pipe line companies."

These points sound promising, but they also involve questions that bear examination. There are several factors which affect the accuracy of meter measurement. At terminals now measuring large volumes of crude oil on a continuous basis, positive-displacement meters are proving accurate within a tolerance of less than 0.1 per cent between meter provings. For lease-tank application, however, many of the favorable conditions available at terminals are not present. It is, therefore, debatable at this time as to whether LACT systems involving accurate positive-displacement metering, with related instrumentation for determining quality and net quantity, monitoring for acceptable bs&w limits, and all on a completely fail-safe basis, can be made at costs comparable to dump-tank system costs. These problems were also discussed at the recent LACT committee meeting and it was generally agreed that a revised issue of API Bull. 2509-A should include a complete and detailed discussion of the factors that govern the success, design, and operation of positive-displacement meter automatic custody transfer systems. Experience with various types of monitors may show that relatively simple velocity types will be acceptable. Fortunately, our company and others are interested and willing to participate in the installation and evaluation of any system which holds promise of improving measurement accuracy economically.

Conservation

Comments concerning the opportunities for a reduction in the loss of the lighter hydrocarbons are very interesting and may well represent the greatest resulting benefit from LACT, providing the pipe lines and refineries are equipped to retain these lighter fractions when delivered to them. To my knowledge this is the first published indication of the possible magnitude and value of such conservation methods. Many producing companies are cognizant of its possibilities and both pipe lines and refineries must evaluate how they can meet the problem. It appears to be a pure case of economics to consider whether the cost of handling the additional available volume is sufficiently less than its value delivered and processed.

Summary

All operators should become familiar with what LACT systems can do and what impact they will have on their operations. From the pipeliners' viewpoint, an attempt has been made to touch on those considerations which appear most pertinent to the subject now and in the foreseeable future.

As R. A. Hamill puts it, it used to be that the milk processor would drive into the dairy farm and pick up a load of cans; but now he drives up with a tank truck and the farm must be equipped with a tank for the truck to receive from. Increasing costs and competition require every industry to stay progressive, and those who don't will find their service in less demand and their margin of profit diminishing.★ ★

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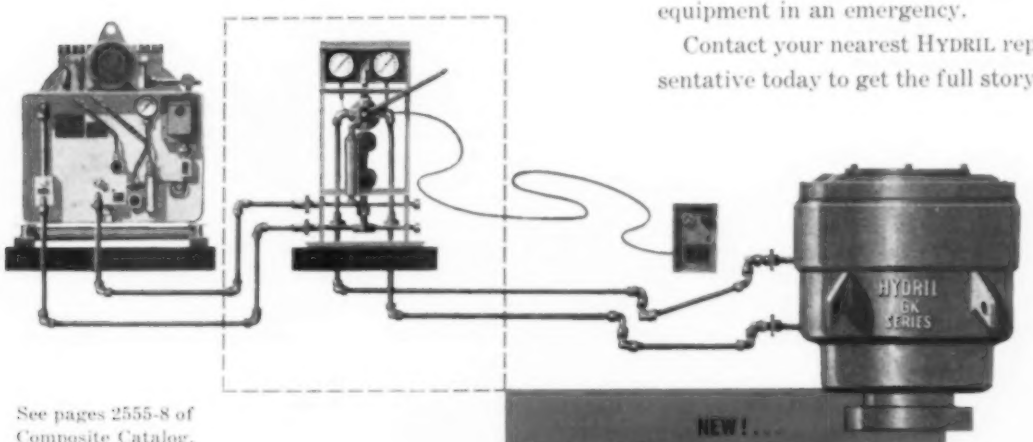

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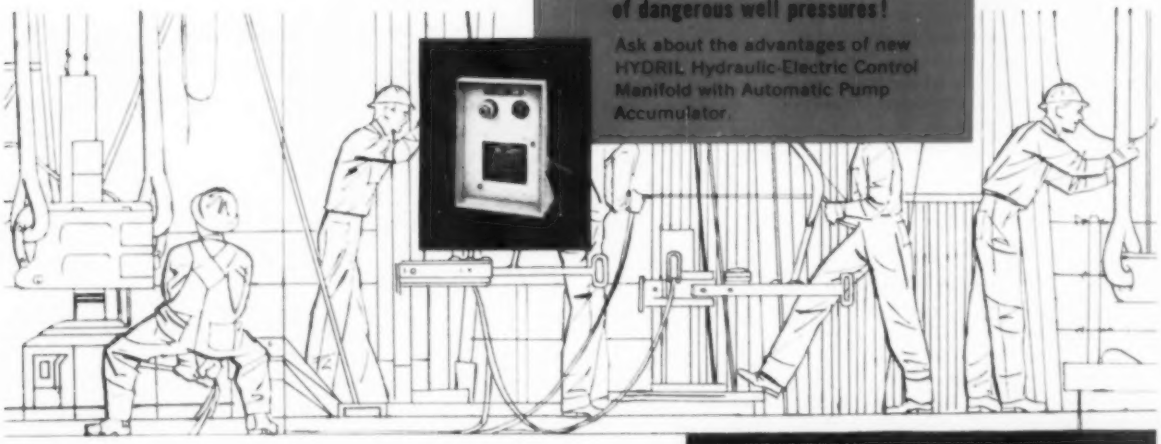

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How to DETERMINE HOLE CURVATURE

Dog-leg severity between two successive directional survey stations can be determined quickly by the use of charts that eliminate lengthy calculations

LARGE savings have been made in recent years in drilling "crooked" holes by not decreasing weight on the bit, and whenever possible, by permitting the deviation to build up to larger values than in the past. However, in the presence of faults and/or unconformities, even if the deviation is permitted to build up, the weight is still frequently decreased because of a fear that the hole might drift in an undesirable direction or that a severe dog-leg might result. If conventional inclinometer surveys were replaced by single-shot direction surveys, then these fears could be eliminated and more weight could be carried, thus realizing additional savings. Such surveys would permit one to know, at any time, the direction of the drift, and to detect dog-legs. The British-American Oil Producing Company runs such surveys in all their wells drilled in crooked hole areas in Oklahoma. This company claims that rental costs of a non-magnetic drill collar and a single-shot instrument, which are of the order of $30 per day, are largely offset by drilling savings.

A dog-leg, even a severe one, does not cause immediate trouble, because the drill collars, being under compression, accommodate themselves easily to variations in the hole course. It is only much later that a dog-leg may become responsible for troubles and large monetary losses. When drilling a few thousand feet below the dog-leg, tool joints at the vicinity of the dog-leg press against the wall of the hole with a large force. Detrimental effects of this force are:

1. Fast wear of tool joints.
2. Key seats in the hole.
3. Worn spots in the casing, which may result in its collapse early in the producing life of the well.

In addition, dog-legs may cause pumping difficulties.

Therefore, early detection of dog-legs is desirable. In the event one appears in the hole far above the expected total depth, and if the dog-leg is very severe, then it should be reamed or the hole sidetracked. Fortunately, severe dog-legs, which generally occur in formation unconformities, are rare. Although it is not known from statistical data, it may be estimated that they occur once in 50 or 100 wells drilled in "crooked" formations.

A clause of maximum dog-leg severity is currently being written into British-American drilling contracts pertaining to wells in which the surface location is chosen by the contractor.[1,2] In these wells, advantage is taken of the natural drift of the hole instead of attempting to combat it.

The dog-leg severity is generally expressed in degrees per 100 ft. For explanatory purposes, consider a simple case in which the direction of the drift does not change and directional data are not needed. Imagine two successive surveying stations 50 ft apart. Assume that hole inclinations are four and six degrees at the two stations. Then the average dog-leg severity between these stations is equal to:

$$6 - 4 = 2 \text{ deg}/50 \text{ ft}$$

$$= 2 \times \frac{100}{50} = 4 \text{ deg}/100 \text{ ft.}$$

In directional drilling, whipstocks are generally set so as not to exceed a dog-leg severity of 5 deg/100 ft, which does not result in any trouble. Therefore, such dog-legs can also be accepted in non-directional drilling. How much more severe dog-legs could be tolerated depends upon the distance from the dog-leg to the total depth and size of hole, drill pipe, casing, tubing, sucker rods, etc. Effect of these variables on the maximum tolerable severity of dog-legs will be better known after more theoretical work is done and more field data are gathered.

Determining average severity. Several means are available for determining the average severity of a dog-leg in the general case when the dog-leg is due to a change in both the inclination and the direction. Eastman Oil Well Survey Company uses a graphical method that requires use of either a protractor and a compass or an apparatus incorporating these two and called "Ouija Board."[3,4] Stanolind Research Department developed means consisting of the use of trigonometric formulae. British-American uses a method[5] in which the results are not given in degrees per 100 ft, as is normally the case.

In this paper, a new chart is presented which permits one to read the dog-leg severity directly.

Terminology. The problem of determining dog-leg severity was discussed on July 31, 1956, at a meeting of the Crooked Hole Subcommittee of the AAODC Rotary Drilling Committee, held in Midland, Texas. The desirability of standardizing the terminology was stressed. In the past, dog-leg severity has also been designated as follows: Rate of change of the overall angle (Stanolind); horizontal departure (British-American); and hole curvature. The committee recommended the following designation: "Hole curvature (dog-leg severity)." This first expression is destined to be used in drilling contracts and the parenthetical expression is temporarily added to assure a fuller understanding of field personnel.

Editor's Note: **This paper was prepared from a report "Chart for Determination of Hole Curvature" by Arthur Lubinski, research associate, Stanolind Oil and Gas Company, Tulsa, Oklahoma, as a member of the API Mid-Continent District Study Committee on Straight Hole Drilling, headed by T. W. G. Richardson, Shell Oil Company, Tulsa. It was presented at the Committee's meeting October 31, 1956, in Oklahoma City. Also included are prepared comments by two committee members.**

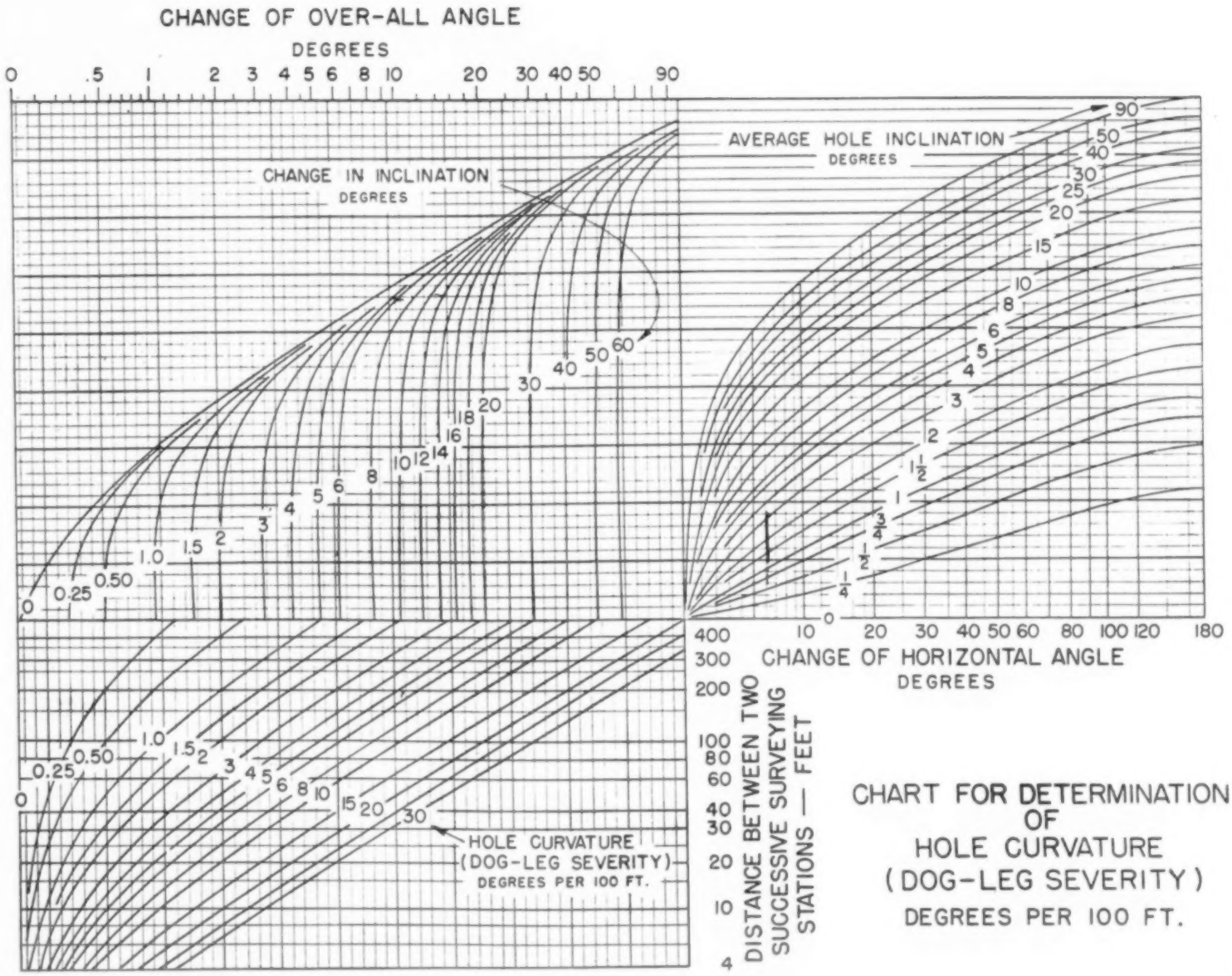
CHANGE OF OVER-ALL ANGLE
DEGREES
0 .5 1 2 3 4 5 6 8 10 20 30 40 50 90
CHANGE IN INCLINATION
DEGREES
0 0.25 0.50 1.0 1.5 2 3 4 5 6 8 10 12 14 16 18 20 30 40 50 60
AVERAGE HOLE INCLINATION
DEGREES
0 ¼ ½ ¾ 1 1½ 2 3 4 5 6 8 10 15 20 25 30 40 50 90
CHANGE OF HORIZONTAL ANGLE
DEGREES
0 10 20 30 40 50 60 80 100 120 180
DISTANCE BETWEEN TWO SUCCESSIVE SURVEYING STATIONS — FEET
400 300 200 100 80 60 40 30 20 10 4
HOLE CURVATURE
(DOG-LEG SEVERITY)
DEGREES PER 100 FT.
0 0.25 0.50 1.0 1.5 2 3 4 5 6 8 10 15 20 30

CHART FOR DETERMINATION OF HOLE CURVATURE (DOG-LEG SEVERITY) DEGREES PER 100 FT.

PROCEDURE FOR PREPARING CHART

The formula of hole curvature is derived in the Appendix, by use of solid geometry and trigonometry. Means by which this formula was used in preparing the chart is also given in the Appendix.

Discussion and Results

With the prepared chart, the average value of hole curvature (dog-leg severity) between two successive directional survey stations may be directly obtained. Use of the chart will be explained with the following numerical example:

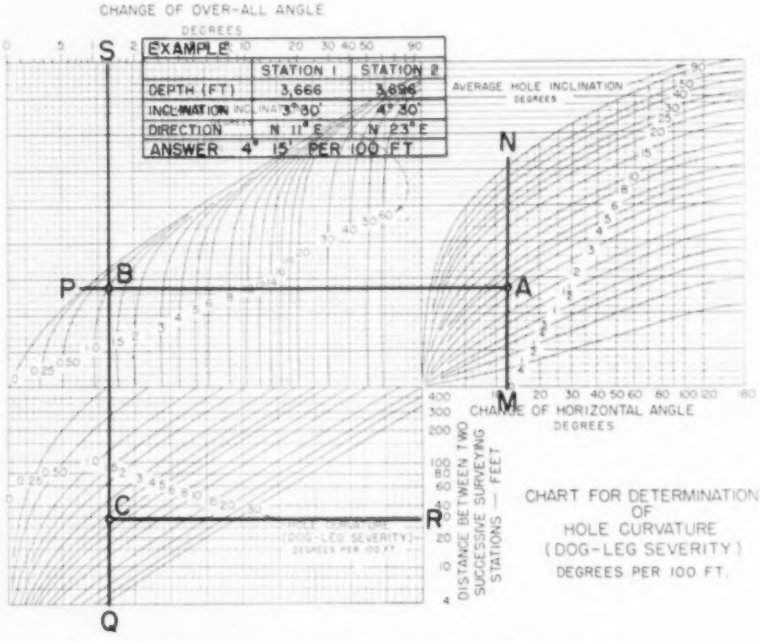

FIG. 1. **Hole curvature** or dog-leg severity can be determined quickly as illustrated here by a chart which incorporates all calculations required. In this sample case, hole curvature was estimated at 4° 15' per 100 ft.

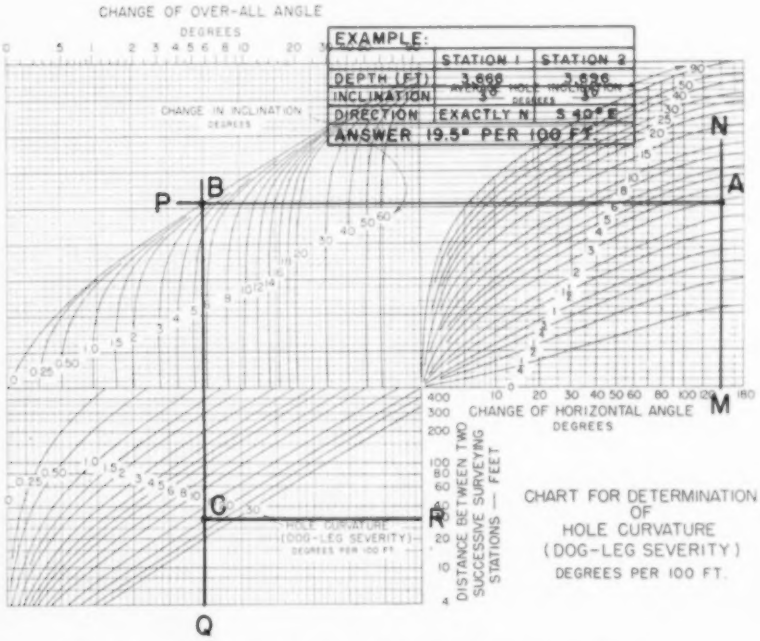

FIG. 2. **Severe case of hole curvature** is illustrated above, although there was no change of hole inclination between two survey points 30 ft apart. In this case, a large change in horizontal direction accounted for the curvature.

	Station 1	Station 2
Depth (ft)	3666	3696
Inclination with respect to vertical	3° 30'	4° 30'
Direction of the inclination	N 11° E	N 23° E

The following calculations must first be made:

(1) Change of horizontal angle
$23° - 11° = 12°$

(2) Average hole inclination
$\frac{1}{2}(3\frac{1}{2}° + 4\frac{1}{2}°) = 4°$

(3) Change in inclination
$4\frac{1}{2}° - 3\frac{1}{2}° = 1°$

(4) Distance between the two successive surveying stations
3696 ft — 3666 ft = 30 ft.

How hole curvature (dog-leg severity) is determined with the chart is shown in Fig. 1.

Since the change of horizontal angle is 12 deg, construct the vertical line MN. Find its intersection with the 4 deg curve at A (4 deg is the average hole inclination). Proceed along the horizontal line AP until its intersection with the 1 deg curve at B (1 deg is the change in inclination). Construct the vertical line BQ. The horizontal line from R (30 ft is the distance between stations) intersects BQ at C, which indicates the following answer:

Average hole curvature (dog-leg severity) between the two surveying stations = 4° 15′ per 100 ft.

In this case, the rate of change of hole inclination is 1 deg per 30 ft, i.e. 3.3 deg per 100 ft. Therefore, the contribution of the change of the horizontal angle, although not negligible, is not predominant.

The following example illustrates a situation in which the change of horizontal angle does predominate.

	Station 1	Station 2
Depth (ft)	3666	3696
Inclination with respect to vertical	3°	3°
Direction of the inclination	Exactly N	S 40° E

Then,

(1) Change of horizontal angle = 140°

(2) Average hole inclination = 3°

(3) Change in inclination = 0°

(4) Distance between the two successive surveying stations = 30 ft.

In a similar manner, as for Fig. 1, average hole curvature (dog-leg severity) between the two surveying stations under consideration, as obtained from Fig. 2, is equal to 19.5 deg per 100 ft.

There is a scale on the chart which, being of less significance, has not been explained so far, namely, the scale of the change of overall angle rather than hole curvature, which is the rate of change of this angle. In the case of Fig. 1, the change of overall angle is read at S and is equal to 1.30 deg. This value

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Powerful McCullough M-3 Guns Fire 9738 Improved Ogival Bullets in One Well—One Job—Rig Time, 117 Hours

McCullough gun perforating crews, using hard shooting, deep penetrating M-3 Bullet Guns, have again broken their record for shooting the most holes in one well on a single job—and turning in a fine producer, to boot!

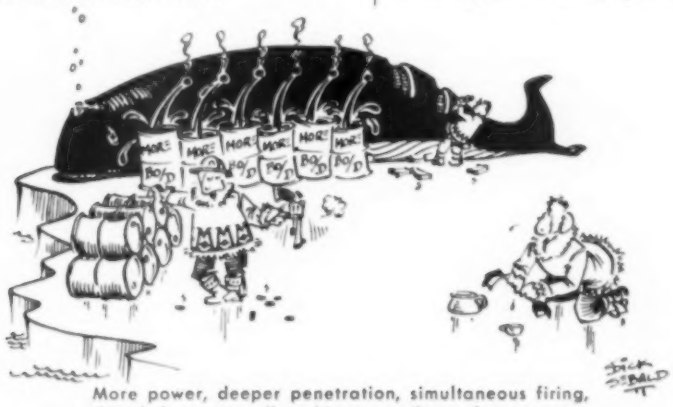
9738 improved ½" Ogival Burrless Bullets were fired in several pay zones. Total depth was 9510 feet and 7" O.D. 26 lb. and 29 lb. N-80 casing had been cemented through the productive intervals. Guns used were the 4¼" O.D. M-3 Bullet Perforators . . . the world's best!

The well started flowing after perforating began and made 1700 barrels of oil during the job. A blowout preventer had to be used to keep the well under control, indicating the extent of the problems overcome to accomplish this all-time record.

Records like this can only be established by M-3 Bullet Guns; the original solid steel bodied bullet guns that fire all shots at one time and gain deeper penetration than any other bullet gun. These guns save valuable rig time on any perforating job. On jobs over 100 holes the saving is substantial. On this record breaker the operator realized a tremendous saving; McCullough crews fired an average of 83 burrless bullets per hour.

All 9738 bullets shot in this well were improved ogival McCullough Burrless Bullets. The entire perforated zone was scraped on a single run. The scraper came out without a scratch—no damage from burrs or bullets; and the zone washed perfectly!

This entire operation was as smooth as silk—a fine tribute to the skill and efficiency of McCullough gun crews and to the excellent completion program established by the oil company's engineers.



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may also be obtained from the previously determined value of hole curvature in the following way:

4.25° per 100 ft is approximately equal to 1.3° per 30 ft.

References

1. "Unique Contract Plays Part in Oklahoma's Deepest Well," Claude Barrow; *Drilling*, March, 1956.
2. "Two Contract Features That Promote More Economical Drilling," Fred Norris; paper presented at API Division of Production Meeting, Wichita, Kansas, April, 1956.
3. "The Eastman Removable Whipstock," Instruction Book 4914, published by Eastman Oil Well Survey Company.
4. "Eastman Knuckle Joint," Instruction Book 5018, published by Eastman Oil Well Survey Company.
5. Discussion by R. W. Moore of the paper "The Need for a Definition of a Crooked Hole," by R. B. McCloy, presented at the 1952 spring district meetings of the API, held in Wichita, Kansas, and Shreveport, Louisiana.

DISCUSSION OF CHART

Robert W. True
Big Chief Drilling Company
Oklahoma City, Oklahoma:

The greatest push received by operators and contractors alike in drilling holes in areas of steeply deviating beds is the company's relaxation of previously minimum deviation limits. Including this acceptance of slant-hole drilling in contracts has definitely reduced the cost of drilling these holes and has greatly reduced the risk involved in mimimum deviation control which prevailed previously. While some have made attempts to determine dog-leg severity through calculations, it is felt that these charts will greatly simplify the problem and reduce the time required when determining dog-leg severity angles.

Field Examples. Our records reveal that in the case of wells drilled in Garvin County and particularly in the Eola field area where crooked hole problems can be severe, these holes change direction as well as angle in relatively short intervals.

In one particular example, deviations changed from 6°N 40°W to 7°N 50°E in 60 ft. An analysis of this case by use of these charts indicates a dog-leg severity of approximately 15 deg. This can be termed as an actual example of this type of curvature, especially in this particular well. Surprisingly enough, this angle encountered occurred at around 6500 ft. The well was drilled ahead to approximately 11,500 ft. Sixty to 70 days were required to go from 6500 to 11,500 ft. During this time there was no indication of key-seat or dog-leg trouble. The well was completed without incident.

To cite an example of holes where minimum deviation was allowed at 3 deg to a total depth of 8500 ft, key-seats sufficient to give trouble were experienced where the maximum deviation at the point of the key-seat was not over ¾ deg. Examining this particular example by means of these charts, the dog-leg severity is found to be nil. Of course, the depth at which the key-seat occurred was approximately 2300 ft, but the time in the hole below this depth was only 15 days. While it could be assumed possibly that this key-seat was due to a lime edge, wash out, etc., allowing the key-seat to form rapidly this example is given just to illustrate the point that key-seats are entirely possible under minimum deviation control, especially when the hole is allowed to wander back and forth within the specified deviation limits. Once a hole has started deviating, care should be taken to prevent the hole from straightening up too rapidly irregardless of the total angle involved.

These examples are given just to illustrate what is possible with slant-hole type drilling and also to explain the point whereby minimum deviation control can cause hazards which, for the moment anyhow, many times are probably overlooked. No definitions were given of the particular formation, bit weights, etc., in these instances, but they are sufficient to express what can happen in such cases.

Therefore, in the case of Big Chief Drilling Company, and of most contractors and operators, it is felt that whenever possible, the deviation limits should be relaxed to the greatest extent. By so doing, it would increase the efficiency of the operation as well as reduce the overall hazard of drilling.

R. B. McCloy,
Big X Drilling Company,
Oklahoma City, Oklahoma:

The "Chart for Determination of Hole Curvature" presents a simple method of placing a numerical value on hole curvature, so that for a given area with some experience it should be possible to eliminate ordinary drift readings and utilize curvature measurements. A comparison of Examples 1 and 2 in the paper indicates the fallacies of drift readings on which a large part of the industry now depends. Example 1 would be considered by many to be a hazardous situation since the drift increases from 4 deg to 6 deg in 50 ft of hole. Since the direction did not change, the curvature is 4 deg per 100 ft. By comparison with Example 3, the drift had not changed, which would be considered by many to be a good hole. By using the chart, it is noted that the curvature for Example 2 is 19.5 deg per 100 ft, which compares with 4 deg per 100 ft in Example 1. This is not surprising to those who have studied the problem closely, but utilization of the chart makes it very simple to determine curvature and by comparison with drift, the chart should be helpful in amplifying the difficulty of using a drift reading alone. The chart gives the same values, without the use of mathematics, as calculated by Wesley Moore of The British-American Oil Producing Company in the method previously presented by him.

This committee, four years ago, pointed out the "Need for Definition of a Crooked Hole." That paper was prepared to provoke thinking while the complete problem was studied. With the chart and some experience, a crooked hole may soon be defined. To make this definition a reality, this committee should review directional surveys, determine the curvature from Lubinski's charts, correlate with drilling or producing problems, and for certain areas determine the maximum value that can be tolerated without difficulty.

To the three difficulties of dog-leg severity given (fast tool joint wear, key seats, and worn casing) another could be added. Currently attracting attention is that of wall hanging of drill pipe or drill collars due to the differential pressure between the hydrostatic head of the mud and formation pressure.

Floor Discussion

Construction of the chart is based upon an approximation which gives values of hole curvature that are somewhat too large. The error is negligible if the ratio of hole inclination in two successive survey stations is no greater than two. In almost all actual cases this ratio is smaller than two except when the hole is close to vertical at one of the stations. If the ratio is greater than two, then the above-mentioned error may be eliminated by considering the average hole inclination as a geometrical rather than an arithmetical mean. Example:

Station 1
Inclination = 0° 30′ = ½ deg
Station 2
Inclination = 4° 0′ = 4 deg
Arithmetical mean =
½ (½ + 4) = 2.25 deg
Geometrical mean =
$\sqrt{(½)\ (4)} = \sqrt{2} = 1.41$ deg

APPENDIX

Derivation of Formulae

Fig. 3 represents two vertical planes OAFE and OAHG intersecting along the vertical line OA. Consider that at a certain depth the tangent to the axis of the hole is parallel to the plane OAFE and that the angle AOB, designated as v_o, is equal to the inclination of the hole. Consider that somewhat deeper in the hole the axis of the hole became parallel to the plane OAHG and that the angle AOC, designated as v_1, is equal to the new inclination of the hole. The change of horizontal angle is represented by the angle FAH, designated as

Δh. The overall change of angle is, of course, equal to the angle BOC and is designated as Δa.

The following relationships are obvious when considering the right triangles OAB and OAC respectively:

$$AB = OA \tan v_o \quad (1)$$

$$AC = OA \tan v_1 \quad (2)$$

In the triangle ABC:

$$\overline{BC}^2 = \overline{AB}^2 + \overline{AC}^2 - 2\, AB\, AC \cos(\Delta h) \quad (3)$$

Substituting (1) and (2) into (3):

$$\overline{BC}^2 = \overline{OA}^2 [\tan^2 v_o + \tan^2 v_1 - 2 \tan v_o \tan v_1 \cos(\Delta h)] \quad (4)$$

In the right triangles OAB and OAC respectively:

$$OB = \frac{OA}{\cos v_o} \quad (5)$$

$$OC = \frac{OA}{\cos v_1} \quad (6)$$

In the triangle OBC:

$$\overline{BC}^2 = \overline{OB}^2 + \overline{OC}^2 - 2\, OB\, OC \cos(\Delta a) \quad (7)$$

Substituting (4), (5), and (6) into (7) and solving for $\cos(\Delta a)$, and proceeding through a few transformations:

$$\cos(\Delta a) = \cos v_o \cos v_1 + \sin v_o \sin v_1 \cos(\Delta h) \quad (8)$$

Eq. (8) would be convenient only if Δa were large. For relatively small value of Δa, $\cos \Delta a$ is almost equal to unity and Δa cannot be calculated with tables. For this reason, Eq (8) has been transformed as follows:

$$\cos(\Delta a) = \cos(v_1 - v_o) - \sin v_o \sin v_1 [1 - \cos(\Delta h)] \quad (9)$$

$v_1 - v_o$ is the increase of inclination and will be designated as Δv

$$v_1 - v_o = \Delta v \quad (10)$$

The following relationships are well known:

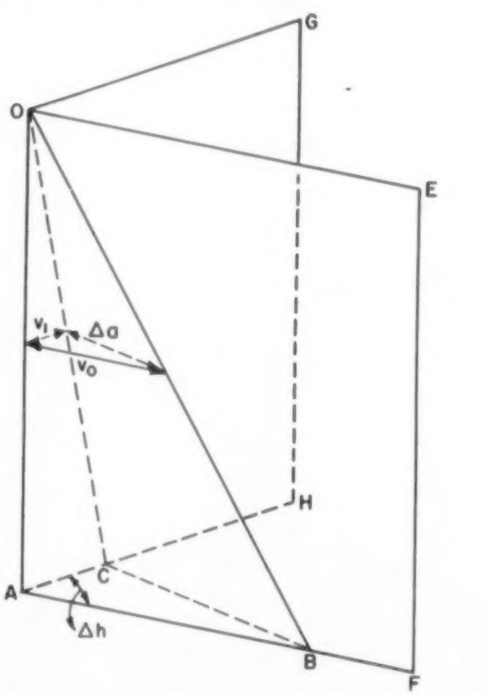


FIG. 3. **Basis of chart construction** is a trigonometric relationship illustrated by two intersecting planes.

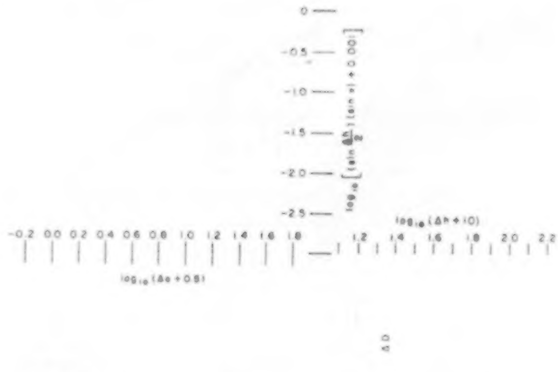


FIG. 4. **Coordinates were distorted** on the chart, as indicated, to provide a more suitable distribution of curves and thereby permit hole curvature determinations for relatively small values of Δa in Fig. 3.

$$\cos(\Delta a) = 1 - 2 \sin^2 \frac{\Delta a}{2} \quad (11)$$

$$\cos(\Delta v) = 1 - 2 \sin^2 \frac{\Delta v}{2} \quad (12)$$

$$1 - \cos(\Delta h) = 2 \sin^2 \frac{\Delta h}{2} \quad (13)$$

Substituting (10), (11), (12), and (13) into (9) and solving for $\sin^2 \frac{\Delta a}{2}$:

$$\sin^2 \frac{\Delta a}{2} = \sin^2 \frac{\Delta v}{2} + \sin^2 \frac{\Delta h}{2} \sin v_o \sin v_1 \quad (14)$$

from which

$$\Delta a = 2 \arcsin \sqrt{\left(\sin \frac{\Delta v}{2}\right)^2 + \left(\sin^2 \frac{\Delta h}{2}\right)(\sin v_o)(\sin v_1)} \quad (15)$$

Generally, the hole inclinations v_o and v_1 at two successive surveying stations are close to each other. Therefore, these inclinations may each be replaced by the average value v; thus, Eq (15) becomes:

$$\Delta a = 2 \arcsin \sqrt{\left(\sin \frac{\Delta v}{2}\right)^2 + \left(\sin \frac{\Delta h}{2}\right)^2 (\sin v)^2} \quad (16)$$

Construction of the Chart

The previously explained chart is a graphical representation of Eq (16).

The abscissa and the ordinate of the upper right section of the chart are essentially Δh and $\left(\sin \frac{\Delta h}{2}\right)$ (sin v) respectively. Several curves, each for a constant value of v, have been computed and plotted.

Also, the abscissa and the ordinate of the upper left section are essentially Δa and $\left(\sin \frac{\Delta h}{2}\right)$ (sin v). Curves for constant values of Δv have been computed and plotted.

The abscissa and ordinate of the lower left section of the chart are essentially Δa and ΔD (distance between two successive surveying stations). Curves for constant values of $\Delta a/\Delta D$ have been computed and plotted.

The word "essentially," used several times in the above paragraphs, means that coordinates have been distorted as indicated in Fig. 4 to get a more suitable distribution of curves. ★ ★ ★

Latex, cement, surface-active agent and water

New Latex-Cement Solves Special Well Problems

J. T. Rollins[1]
and
R. D. Davidson[2]
Dowell Incorporated

Forms stronger bond, is more resilient, resists contamination, has low fluid loss and low shrinkage

MANY well cementing difficulties plaguing the oil operator have been eliminated by the application of a specialized new cementing material. Developed by Dowell Incorporated and used in the company's Cealment service, the new material is a slurry containing latex, cement, a surface-active agent and water. It sets at approximately the same rate as regular Portland-type cement. Some outstanding characteristics of this new latex-cement are: (1) Forms stronger bond with both oil-wet and water-wet surfaces; (2) does not shatter when perforated; (3) resists contamination by well fluids; (4) has low fluid loss and low shrinkage, and (5) has greater durability.

These characteristics provide several practical benefits. Latex-cement used across a pay zone does not, because of its resiliency, shatter and form communication channels to other zones.

[1]Midland, Texas.
[2]Borger, Texas.

The low water content of the latex-cement slurry eliminates two problems. The use of high squeeze pressures to dehydrate the slurry is unnecessary, and flash setting because of premature dehydration does not occur. The low fluid loss of the slurry (less than two per cent of the fluid loss of a Portland-type cement slurry) prevents excessive shrinkage. The limited shrinkage of latex-cement makes for a stronger bond and results in complete shutoffs in squeeze jobs.

Uses of Latex-Cement

Primary applications of latex-cement include:

1. Cementing liners.
2. Tail-in jobs.
3. Squeeze jobs.

The greatest advantage of this material when cementing liners is that its bonding strength is far superior to that of Portland-type cements. Fig. 1 compares the bonding strength of latex-cement and Portland-type cement. It can be seen that the latter's strength ranges from approximately 31 per cent to less than 58 per cent of that of latex-cements.

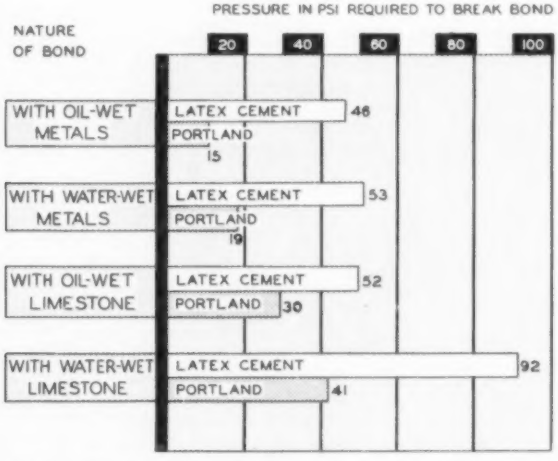


FIG. 1 — **Comparative bonding strengths** of the new latex cement and Portland-type cement.

On tail-in jobs, the special slurry is pumped into the cementing line after the regular cement, followed by the cementing plug. The latex-cement is left at the bottom of the hole, covering the pay formation. When casing is perforated, the latex-cement maintains its bond with both the casing and formation. Perforations through it are clean holes. No channels to other zones occur.

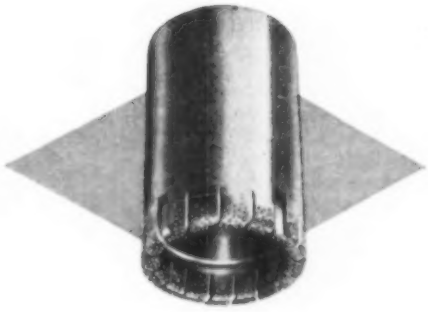
Some of the reasons for which squeeze jobs are performed are the following: (1) Repairing channels that communicate with other zones; (2) repairing casing holes; (3) shutting off bottom-hole water zones; (4) remedying lost circulation during drilling; (5) blocking off water zones by squeezes above and below the producing zone, and (6) extending primary cementing jobs.

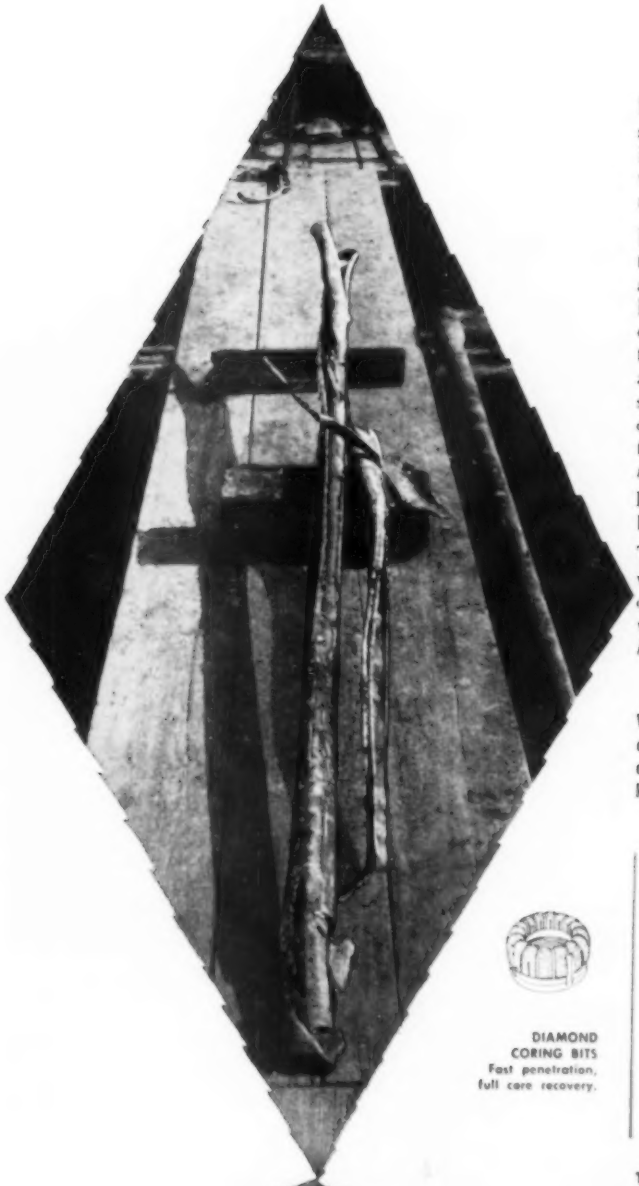
Permian Basin Applications

Although field results are now available from many areas, thus far latex-cement has probably been used most extensively in the Permian Basin of West Texas. For some time after this new cement was available in the Permian Basin, most operators who used it had already tried regular cement without success and faced serious problems. For this reason, latex-cement was tested against the toughest problems a new material could meet. Because of its effectiveness on these difficult jobs, latex-cement is beginning to be used widely by West Texas operators.

Typical of the problems that latex-cement has solved is that of a well in the Spraberry pool. The operator was unsuccessful in six attempts to squeeze-off casing holes at about 4400 ft. On each of these jobs, 150 to 200 sacks of regular cement were applied, and none

D & S washover shoes save time... money!





Drilling & Service Truco diamond washover shoes have performed many extraordinary feats in the oilfield. We cite one example here which tells a graphic story of advantages in using D&S washover shoes for *your* operation:

Recently, one customer had 7" casing set through pay zone. The casing was perforated and a packer set with 2½" tubing. When he started to sandfrac the well, the casing collapsed around the tubing. After backing off the tubing . . . leaving one joint up for a guide, a 5-15/16" x 4-5/8" D&S diamond washover shoe was run on 5½" OD wash pipe . . . cutting over the tubing, packer and cutting out the collapsed casing. This was done in *three days' rig time!* When the wash pipe was pulled, the tubing, portion collapsed casing, packer and anchor joint were retrieved inside it.

Total Truco diamond washover shoe cost was only $850. Experience in this type of operation has shown that conventional methods would have required *more* rig time and *higher* related costs.

WRITE OR CALL TODAY! One of our sales engineers will call on you and explain our custom-services and equipment. Herein lie the real D&S advantages.

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Fast penetration, full core recovery.

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of these squeeze jobs would hold 1000 psi after being drilled out.

The well was then squeezed with 1000 gal of latex-cement. After the wellbore was drilled out, the squeeze job held when tested to 1000 psi.

Another Permian Basin operator had a problem well in which he had tried to shutoff water from the Rustler sand. The water flow washed out the slurry, and he was not able to obtain a shutoff. A 1000-gal latex-cement squeeze job resulted in a complete shutoff.

Hugoton-Panhandle Area

In the Hugoton gas field and the Panhandle (Texas) oil field, uses of latex-cement are similar to those in the Permian Basin. However, the application methods are sometimes different in order to conform with specific area conditions. Conventional pump trucks are used to inject the latex-cement into the well on tail-in jobs. On some jobs, however, a bailer is used, rather than a pump truck.

Water problems in the Panhandle oil field are similar to those in other areas. Most of the difficulties arise from water coning or encroachment from a zone underlying the oil producing zone. The usual solution is a plug-back job. Squeeze jobs are generally employed when water is encountered on initial completion.

Plugging back. Most of the plug-back applications of latex-cement in the Hugoton-Panhandle area have been in old wells completed with open hole. The need for a cheap and simple treatment for these wells has been met in many instances with 15 to 100-gal bailer jobs.

To reduce costs, most of these jobs are performed using machinery and tools already on the well, or placed there by the operator. Only chemicals, mixing equipment, and engineering service are furnished.

Of course, as in any plugging operation, the hole should be cleaned out as completely as possible. The dumping process is done with the sand line on the rig over the hole, and with a bailer furnished by the operator. The ordinary dump-stick bailer commonly used on most cable tool rigs is undesirable, unless only a single dump is to be made. A positive-dump type bailer is preferable because, after the first dump, the slurry already in the hole may not be hard enough to open a dump-stick bailer.

Mixing equipment consists of a portable power plant, an electric mixer, and an open top 55-gal drum equipped

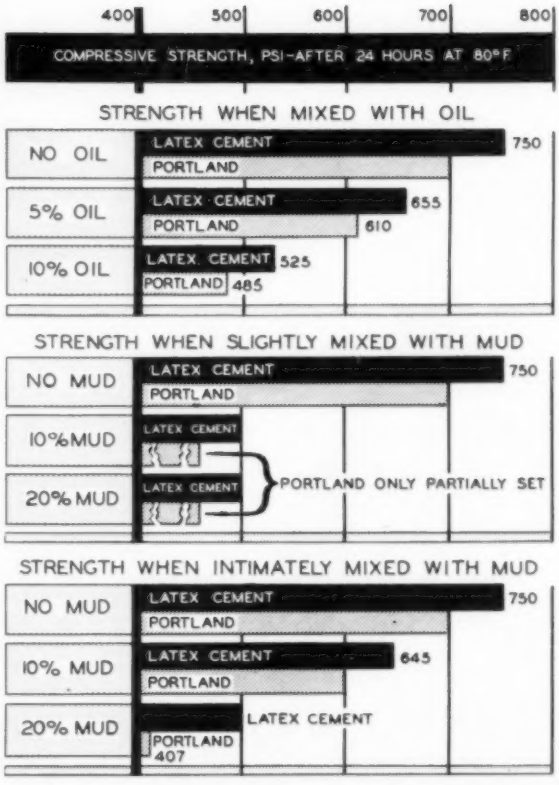


FIG. 2 — **Resistance to contamination** of new latex-cement and that of regular Portland-type cement.

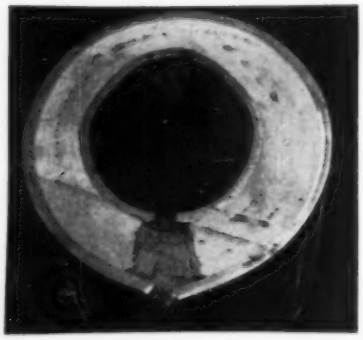


FIG. 4 — **Test sample** shows the resiliency and bonding strength of latex-cement. The sample was prepared by allowing latex-cement to set for 24 hours between two strings of casing. It was then jet perforated and cut apart at the perforation. It can be seen that the bond was maintained and that no shattering occurred.

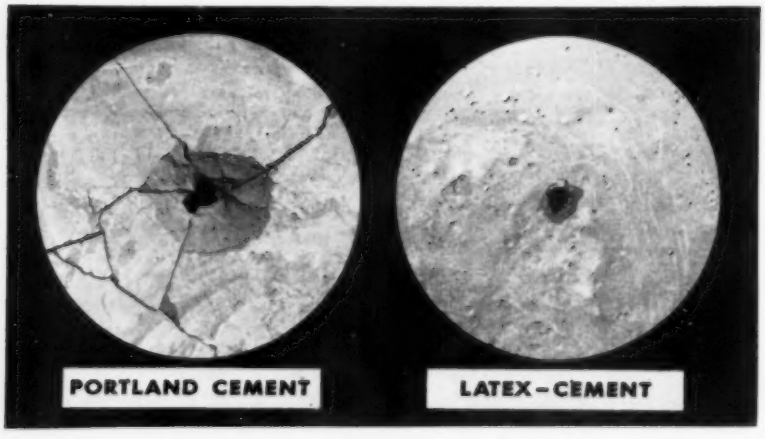


FIG. 3 — **Resiliency and shatter-resistance** of the new latex-cement. Both the Portland-type cement sample and the latex-cement sample were perforated by rifle bullets.

with center braces to support the mixer. This equipment and the chemicals are transported by a radio-equipped, pick-up truck, which also has a wire line measuring device. One or two open top drums containing fresh water are taken along if water is not available on location.

The Authors

R. D. Davidson J. T. Rollins

J. T. Rollins received BS degrees in both mechanical engineering and management engineering from Texas A&M in 1946. He joined Dowell Incorporated in 1950, after working for Rowan Drilling Company and Weatherford Oil Tool Company. He has served Dowell as junior engineer, service engineer, and sales engineer. At present he is petroleum engineer for the West Texas-New Mexico district. He is a member of ASME and AIME, and is a registered professional engineer in Texas.

R. D. Davidson graduated from the University of Oklahoma in 1951 with a BS degree in petroleum engineering. He joined Dowell Incorporated after graduation and has served them as a junior engineer, service engineer, sales engineer, and petroleum engineer. At present he is district engineer for Southwest Kansas and the Texas-Oklahoma Panhandle area.

The well is prepared by cleaning it out and allowing it to reach its normal hydrostatic head. A pre-determined amount of latex-cement slurry is mixed, placed in the bailer, and dumped on bottom. Successive dumps are made to obtain desired fill-up, and a thief is run to ascertain actual fill-up.

After the slurry has been dumped, one to four barrels of water or oil are dumped into the hole. Because few wells in the Panhandle pool will load, this additional load over-balances the system enough to force the latex-cement to seal. Sometimes the process must be repeated until the desired plug-back is obtained. In some cases, lost circulation agents have been used to obtain a fill-up after a reasonable amount of latex-cement has penetrated the formation without effecting a fill-up.

Tailing-in jobs. Because of the excellent results obtained by tailing-in new well completions with latex-cement, one company in the Hugoton-Panhandle area now makes such completions standard practice. Before this new material was available, tracer logs were run after several fracturing treatments. In every case, communication with zones other than the pay was shown to have occurred behind the casing.

After the first of the new tail-in jobs with latex-cement was perforated and fractured, a tracer survey showed complete separation of zones. Tracer surveys were virtually abandoned after this job because the high potentials resulting from fracturing treatments clearly showed that the latex-cement bonded tightly to both the formation and casing and did not channel or shatter when perforated.

Two wells offsetting each other were drilled on 20-acre spacings. Casing in the first well was cemented with regular Portland-type cement, while the second was cemented with Portland, followed by 350 gal of latex-cement across the potential pay zones. Two squeeze jobs performed on the first well failed to isolate the pay zones so that each could be fractured individually. In the second well, which was tailed-in with latex-cement, complete isolation was obtained on all fracturing treatments. The well was completed as a good dual producer from isolated pay zones. ★ ★ ★

Canadian Petroleum Association Elects New Officers at Third Annual Meet

G. L. KNOX, of Calgary, president, The California Standard Company, has been named chairman of the Board of Governors of the Canadian Petroleum Association at a special session of the new Board following the third annual meeting of the Association at Calgary, Alberta, in December.

Knox has been active in petroleum association activities for many years, having been a member of both the Alberta Board of Directors and the General Board of Governors on previous occasions.

Results of the election for members of the Board of Governors were announced by P. L. Kartzke, retiring chairman of the board, during the afternoon business meeting. In addition to Knox, board members from Alberta will be: R. C. Brown, Hudson's Bay Oil & Gas Company Ltd.; C. U. Daniels, Royalite Oil Company, Ltd.; Bart W. Gillespie, Oilwell Operators Ltd.; P. L. Kartzke, Shell Oil Company; E. D. Loughney, Canadian Gulf Oil Company, and Vern Taylor, Imperial Oil Ltd. Representing Saskatchewan on the new board will be: R. A. Bishop, Sohio Petroleum Company; V. H. Hunter, Imperial Oil Ltd., and C. E. Leach, Tidewater Associated Oil Company.

In addition, Alberta Board Chairman, G. E. Dunlap, Sun Oil Company, and vice-chairman, T. W. G. Thomson, Texaco Exploration Company, will be ex-officio members of the board and R. A. Cruickshank, Canadian Devonian Petroleums, and D. M. Tyerman, MacPherson, Leslie & Tyerman, will similarly be ex-officio members representing the Saskatchewan division of the association.

During the afternoon business meeting, John W. Proctor, general manager of the Canadian Petroleum Association, reported that the membership of the association has increased by 18 to 352 during the past year.

E. Hargreaves, chairman of the Statistical Committee, told the members that statistics covering the development of the petroleum industry in western Canada had been gathered over the past year and that a comprehensive statistical publication was available.

P. L. Kartzke, commenting on the activities of the association for the year 1955, stated that the corporate structure of the organization had been revised to more adequately meet the problems of the exploration and production segments of the industry. He advised that the association has been requested on different occasions during the year to set up divisions for refining, transportation and marketing branches of the industry. Kartzke said that this would be a major step in the development of the organization and would require careful consideration by the entire membership. In closing he stated that early consideration should be given this important matter.

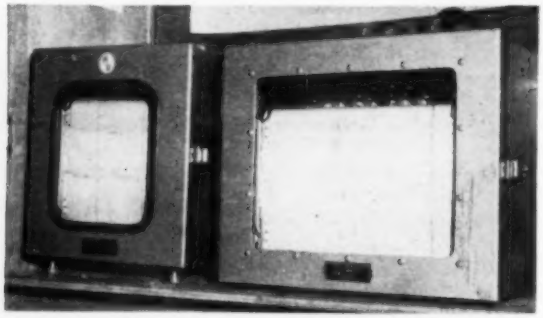
AAODC Conducts Field Research On

Weight-Speed vs Penetration

First tests are underway in Ector County, West Texas, in a new series of controlled engineering studies

Weight-indicator set up on rig floor at Ector County, Texas, location of AAODC weight-speed vs penetration test is observed by Exploration Drilling Company driller L. C. Finley.

Engineers B. C. Groenewold, left, of Exploration Drilling Company, and Jack Knowlton, Martin-Decker Corporation, supervise the test procedure of AAODC weight-speed vs penetation project.



Electric recorders used in these field studies of drilling efficiency. Two-channel recorder, left, registers pump speed and pressure. Four-channel instrument records torque, total hook load, rate of penetration and rotary speed.

CONTROLLED engineering field studies sponsored by the American Association of Oilwell Drilling Contractors are now underway at a drilling operation in Ector County, Texas, seeking new technical data to improve drilling efficiency.

Conducted by an AAODC rotary drilling sub-committee, in cooperation with individual firms, the purpose of the project is to study the relationship of bit weight and rotary speed to the rate of penetration.

Results of the tests will be reported after a series of studies is completed, according to E. L. Decker, subcommittee chairman.

First tests, at a Texas Gulf Producing Company drilling location near Dora Roberts pool, six miles south of Odessa, are being supervised by engineers B. C. Groenewold of Exploration Drilling Company, and Jack Knowlton of Martin-Decker Corporation, which provided the instrumentation for the studies.

Initially, the project will be to hold all drilling functions constant except weight on the bit and, in various formations and under various stabilized rotary speeds, the effect of bit weight changes will be determined.

A second project will be to vary the rotary speed, in various formations and with different weights, to study the effects of changes in rotary speed.

After these relationships have been established, work will be done with the product of weight times speed. This product will be kept constant through changes of bit weight and rotary speed to determine its relationship to rate of penetration.

The measurements are recorded on two instruments mounted in the dog house 150 ft away from the rig floor. The two-channel recorder registers pump speed and pressure, while the four-channel instrument records torque, total hook load, rate of penetration and rotary speed.

Signals for the recording are taken from instruments on the rig floor, and through transducers are altered to electric signals, which are then relayed through electric cord to the recorders.

Each day a length of the continuous strip charts is torn off and studied by the engineers. Results of the day's tests are evaluated and plotted on graphs.

William P. Clements, Jr., Dallas, chairman of the AAODC rotary drilling committee, said the weight-speed vs penetration project is one of several field practice studies now being conducted by AAODC in the search for better drilling methods. ★ ★ ★

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

WIRE ROPE

Jim Walker*

WIRE rope is one of the most versatile tools used in the oil fields. Take a look at different field operations and you will find that there just aren't many jobs in which wire rope doesn't play an important role. As for oil well drilling, it is so vital that no method presently used or contemplated could be performed without wire rope to hoist and lower the tremendous weight of the tools used.

Engineers know that to use a tool best, you must understand its characteristics and limitations. This chapter will reveal the characteristics of wire rope—show how it affects drilling and how drilling affects it.

Strength in wire rope is a function of the cross sectional area and grade of steel used in its construction. Of equal importance, the distribution of load among the wires and strands must be proportional to their respective cross sections in order that the total strength may be utilized. In other words, the line should be in a balanced condition under load.

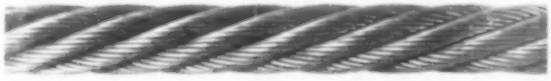
Flexibility in wire ropes is defined as resistance to bending fatigue. It is obtained by the use of smaller and more numerous wires, or more strands in manufacturing the rope. The type of lay and core also affect the original flexibility of a rope. The most commonly used lays are shown in Fig. 2 and 3. Formation of martensite due to rapid and intense temperature changes during scrubbing on the drum and sheaves; continuous and concentrated flexure as at the dead sheave; or, short radius bending adversely affect flexibility.

*Kerr-McGee Oil Industries, Inc., Morgan City, Louisiana.

Colorado Fuel & Iron

FIG. 1. Wire line is heart of hoisting system. Proper sheave and crown block design gives longer rope life.

Right lay — regular lay wire rope.



Left lay — regular lay wire rope.

Roebling

FIG. 2. Wire rope lays.

In regular lay ropes, the wires in the strand are laid in the opposite direction to the lay of the strands. In right regular lay rope, the wires in the strand are laid to the left and each strand is laid to the right. In left regular lay rope, the wires in the strand are laid to the right and each strand is laid to the left.

In Lang lay ropes, the wires in the strand are laid in the same direction as the lay of the strands. In right Lang lay rope, both the wires in the strand and the strands in the rope are laid to the right. In left Lang lay, both the wires in the strand and the strands in the rope are laid to the left.

Jones and Laughlin

FIG. 3. Regular and Lang wire rope lays.

As wire rope is a flexible tool, it always works in tension. It works best when slack is reduced to a minimum. Sudden excessive slack in a loaded line has the same potential effect as placing it in compression; that is, a kink may be thrown into it. Also, the chances of shock loading are greatly increased as the slack is removed by the load.

Elasticity affords an element of safety when shock loads are applied. Elasticity is inherent in the helically bent (not twisted) wires and strands of the rope. The length and type of lay determine the degree of elasticity. Shock loads of relatively low magnitude and/or overloading reduce elasticity.

Resistance to abrasion is a function of outer wire size. It is aided by mechanical peening of the outer wires which presents a greater surface area to abrasive forces. Ductility of the steel used is such that this peening takes place early in the service life of the rope. Lang lay wire rope has greater resistance to abrasion than regular lay ropes because it has greater exposure of the wires at the "crown" of the strands. Lang lay ropes are not commonly used for rotary drilling lines, however, because the total requirements of this service are better met by regular lay ropes.

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

"Universal" Aptly Describes Range of Applications of BAKER Retainer Production Packer

Baker Retainer Production Packer
Product No. 415-D

Baker Locator Tubing Seal Assembly
Product No. 442-E2

ADVANTAGES of the Baker Retainer Production Packer:

1. *Forms positive, leak-proof pack-off against any pressure differential from either above or below the packer that is safe for the casing.*

2. *Pack-off achieved without excessive set-down tubing weight, or tubing in tension.*

3. *Permits tubing string to be anchored to the packer, released from the packer, or completely removed from the packer, all at the discretion of the operator.*

4. *Complete removal of the tubing string from the packer will not disturb the isolation of the zone below the packer, provided the pressure differential is from below the packer.*

5. *Pack-off remains leak-proof under conditions of high temperature, even under pressure differentials that exceed the safety limits of the casing.*

6. *Can be set on wire line, tubing or drill pipe.*

In practically every production application the Baker Retainer Production Packer has earned the designation "Universal" Type; and it appears also to be the answer to many future production problems.

The range of applications is further broadened by its ability to hold high pressures from above or below—at record or shallow depths—even under temperatures in excess of 300 degrees Fahrenheit.

Because it can also be used successfully as a squeeze tool, it is ideal for testing, acidizing, formation fracturing, squeeze cementing, and other operations required in the completion or work-over phases of a well.

The following actual field records of general production, as well as supplemental applications of this "Universal" Type Packer may indicate a solution to your well problems:

PRODUCTION APPLICATIONS

Single-Zone Production—More Baker Retainer Production Packers are used for single-zone production than for any other application—proof of their increasing and widespread usage in a field previously dominated by retrievable type packers.

Dual-Zone, Single-Packer Application—The majority of dual-zone applications of the Baker Packer are single-packer, dual-zone installations. Because of its remarkable ability to maintain the absolute separation of two zones, this packer is widely known and accepted as the ideal dual-zone packer.

Dual-Zone Production (Baker Selective Hook-Up), Two-Packer Installation—This efficient hook-up enables the operator to produce (pump or flow), treat (formation fracture, acidize, etc.), or test either zone selectively through the tubing, while simultaneously producing the remaining zone through the annulus. The switch in flow, or selection of a zone for treatment, is accomplished at the discretion of the operator, using an instrument line.

Permanent-Type Well Completions—Long recognized as the world's most permanent production packer, the Baker Retainer Production Packer was accepted early in the development of this new completion idea as OUTSTANDINGLY FIRST for Permanent-Type Well Completions.

Parallel Tubing Installations—When a *single* packer is used, each tubing string can be run or pulled independently of the other, and by using a special Anchor and a Latching Sub, the short string can readily be anchored to the long string.

When *two* packers are used, each string is run or pulled separately, however, the long string must be *run* first, and the short string *pulled* first. Either the single-packer or the two-packer installation features a full opening to the lower zone for use of all permanent completion-type tools.

Off-Shore Installations—The Baker Packer is used in conjunction with a storm choke to prevent loss of production due to accidental damage to surface connections of off-shore installations. Permanence, plus the ability of the packer to hold mud weight above the packer are additional factors that recommend its use in this application.

SUPPLEMENTAL APPLICATIONS

In addition to its use in practically every type of production application, the Baker Retainer Production Packer can also be used effectively as a squeeze tool in the following wide variety of "Supplemental" applications that might be required in the completion or work-over phases of a well:

Testing—As many as ten Baker Packers have been used in a single well for an efficient, complete bottom-to-top testing program. Ability of the packer to withstand reverse in pressure differential from high-pressure acid squeeze to swabbing enhances its use as a successful testing tool.

Acid Squeeze, Formation Fracture, or Squeeze Cementing—Use of the Baker Packer as a squeeze tool in either the initial completion or during subsequent work-over is widespread, due to elimination of the unnecessary additional expense of running a separate squeeze or testing tool.

Water Flood or Gas Injection—The permanence of the Baker Retainer Production Packer, plus the advantage of a free tubing string, make it a superior packer for secondary recovery instal-

lations. The packer has also been used in dual-zone wells where one zone is produced, with simultaneous injection into the other.

Isolation of Annulus—The Baker Packer is corrosion resistant. This feature, plus the fact that the packer permits removal of the production string without disturbing the isolation of the zone below the packer (pressure differential must be from *below* the packer) make it an ideal packer for use in corrosive areas where protection of the casing above the producing zone is of great importance.

Bridge Plug, Temporary or Permanent—The Baker Packer acts as a one-way bridge plug whenever the tubing is removed from the well, provided the pressure differential is from below the packer. It can easily be converted to a temporary two-way casing bridge plug or a permanent bridge plug.

POPULAR APPLICATIONS OF: the Baker "Universal" Type Retainer Production Packer

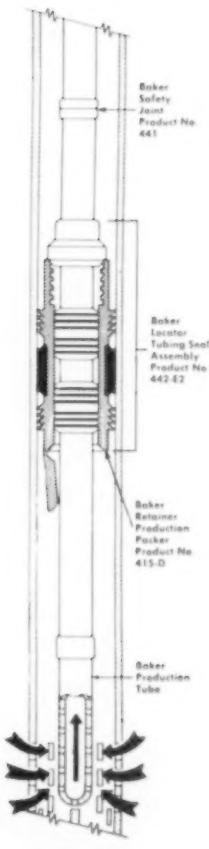

Baker Safety Joint Product No. 441
Baker Locator Tubing Seal Assembly Product No. 442-E2
Baker Retainer Production Packer Product No. 415-D
Baker Production Tube

Fig. 1

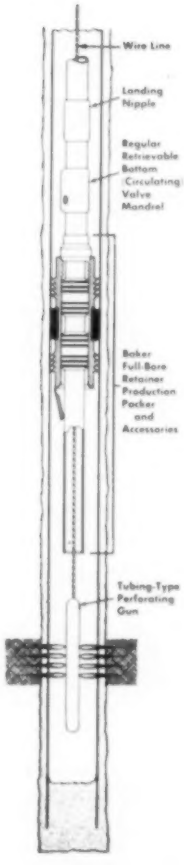

Wire Line
Landing Nipple
Regular Retrievable Bottom Circulating Valve Mandrel
Baker Full-Bore Retainer Production Packer and Accessories
Tubing-Type Perforating Gun

Fig. 2

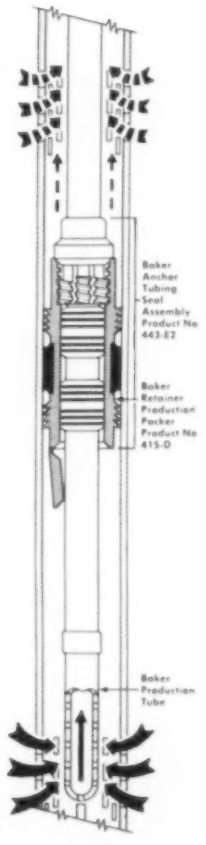

Baker Anchor Tubing Seal Assembly Product No. 443-E2
Baker Retainer Production Packer Product No. 415-D
Baker Production Tube

Fig. 3

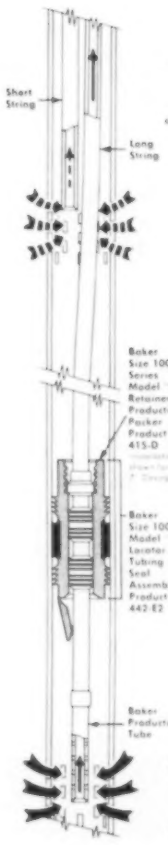

Short String
Long String
Baker Size 100 Series Model "D" Retainer Production Packer Product No. 415-D
Baker Size 100 Model "E" Locator Tubing Seal Assembly Product No. 442-E2
Baker Production Tube

Fig. 4

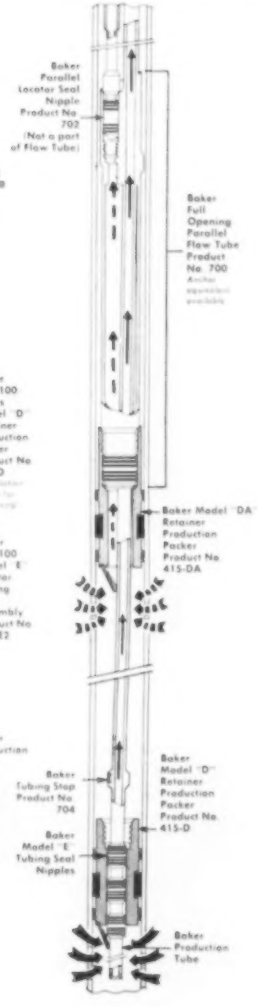

Baker Parallel Locator Seal Nipple Product No. 702 (Not a part of Flow Tube)
Baker Full Opening Parallel Flow Tube Product No. 700
Baker Model "DA" Retainer Production Packer Product No. 415-DA
Baker Model "D" Retainer Production Packer Product No. 415-D
Baker Tubing Stop Product No. 704
Baker Model "E" Tubing Seal Nipples
Baker Production Tube

Fig. 5

SINGLE-ZONE Fig. 1.—Illustrates Packer set in casing with Locator Tubing Seal Assembly and Production Tube installed for single-zone production.

PERMANENT-TYPE WELL COMPLETION Fig. 2—Illustrates typical Permanent-Type Well Completion Hook-Up showing perforating operation through and below the packer.

DUAL-ZONE, SINGLE PACKER Fig. 3—Illustrates Packer set in casing with anchored production string for dual-zone production. Tubing can be released from packer by rotating to right.

DUAL-ZONE, PARALLEL STRINGS, SINGLE PACKER Fig. 4—Illustrates the simplest form of parallel string installation. A variation permits anchoring short string to long string, if desired. Note full opening to lower zone for use of all permanent completion-type tools.

DUAL-ZONE, PARALLEL STRINGS, TWO PACKERS Fig. 5—Illustrates two-packer parallel string installation with each zone confined to its individual tubing string, with full opening to lower zone for use of all permanent completion-type tools.

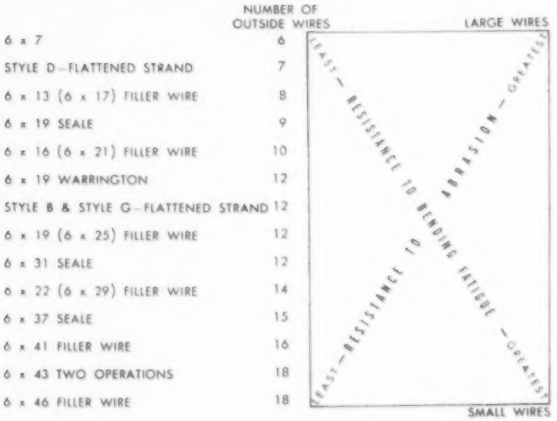
How to get complete information...

A new 72-page catalog supplement is now available on the Baker Retainer Production Packer and its many features and applications. Address any office, or ask your Baker representative for Baker Catalog Supplement No. 502.

BAKER OIL TOOLS, INC.

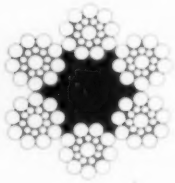
HOUSTON • LOS ANGELES • NEW YORK

Drilling Fundamentals



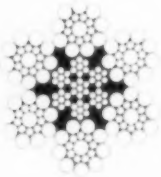
Leschen Wire Rope Division
H. K. Porter Company, Inc.

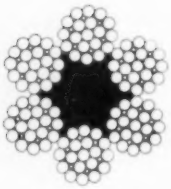
FIG. 4. Graph shows relation between flexibility of wire ropes and their resistance to abrasion.



6 x 19
Seale construction with fiber core.
Rotary and cable tool drilling line
and casing line.

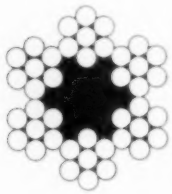
6 x 19
Seale with independent
wire rope core.
Deep or "Big Rig" rotary drilling
and casing lines.





6 x 25
Filler wire with fiber core.
Sucker rod and tubing lines or
coring rig drilling lines.

6 x 7
Fiber core. Sand and coring line.



6 x 25
Filler wire with
independent wire rope core.
Winch lines.

Roebling

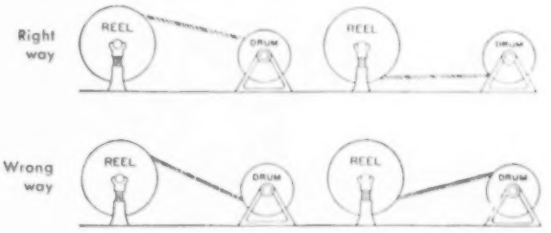
FIG. 5. Designs commonly used in the oil field industry.

RIGHT WAY. This is the correct application of wire rope clips. All the saddles of the clips are in contact with the load end of the rope and the clips are correctly spaced.

WRONG WAY. This is the incorrect application of wire rope clips. The clips are too close together and clips No. 1, No. 3 have the U bolts in contact with the load end of the rope.

Wire Rope Corp. of America

FIG. 6. Method of attaching wire rope clips.



Broderick & Bascom

FIG. 7. Right and wrong methods of transferring line from reel to drum.

Resistance to Crushing and Distortion. In order for each wire and strand to carry its share of the load, it is necessary for each to maintain its position relative to the other wires and strands. Crushing and/or distortion tend to destroy this relationship. The primary purpose of the core is to space and support the strands, i.e., provide crushing resistance. Support is most important on the drum as the rope nears the end of its useful life.

Distortion has two differing effects on strength. Temporary distortions, as over a sheave, cause uneven distribution of the load so that the wires furthest from the groove carry more than those closer to the groove. This is most important at the dead sheave because the line is very restricted as to movement at that point and the same wires and strands carry disproportionate loads over extended periods of time or service. Partial elimination of this condition is the purpose of slipping between cuts. Permanent distortions such as dog-legs, kinks and high strands throw the entire load on part of the wires and strands.

Resistance to Corrosion. Corrosion may reduce strength by reduction of cross-sectional area and/or flexibility by the formation of rust between the wires so that their ability to slide along each other is handicapped. Corrosion is a result of lowering the rope into the well fluids (as a coring line or sand line) or dragging it over corrosive mud materials or earth when pulling it from the reel to string up or unstring.

Protection from corrosion is largely a matter of factory-applied lubrication aided by proper cleaning and field lubrication on removal of the rope from corrosive media. Corrosion is especially insidious in lines that have most of the lubricant squeezed or otherwise removed from the fiber core and wires. The core may then act as a wick, drawing the corrosive agent up into the rope where it attacks the hidden inner wires while the outer wires remain

CUT ALONG THIS LINE FOR YOUR PERSONAL REFERENCE FILE.

Drilling Fundamentals

An important consideration in spooling of the wire line is to have sufficient weight on the line at all times so as to provide spooling on the drum under tension. Insufficient weight will cause loose spooling and result in unsatisfactory rope service. It is therefore imperative that the combined weight of the traveling block, hook, elevators, links and swivel be heavy enough to cause the line to spool under tension.

Wire Rope Corp. of America

FIG. 8. Spooling under tension.

bright due to abrasion.

The materials used and methods of making and using wire rope prohibit the utilization of any of these characteristics at 100 per cent efficiency. Flexibility is often sacrificed to attain resistance to abrasion, and vice versa, dependent on the ultimate use of the rope. (See Fig. 4.) Maximum resistance to crushing (as obtained in a steel bar) must be sacrificed to obtain flexibility. An independent wire rope core may be used in preference to fiber because of its greater resistance to crushing, etc. These difficulties are resolved in the design of the rope. For instance, the Seale Design is the most used for rotary drilling lines. This design has large outer wires to resist abrasion and smaller inner wires to give flexibility. Some typical oil field wire rope designs are shown in Fig. 5.

Regardless of the rope design used, to obtain maximum service it is imperative that the auxiliary items used to guide and control the rope (the dead-line anchor, line stabilizers, sheaves, drums, drum-line turn-backs, clips, etc.) be of the proper size, in good condition, and properly applied. (See Figs. 6, 7 and 8.) The characteristics have shown the ways in which wire rope can become damaged and point the way to avoidance of damage. The control mechanisms provided by engineering know-how not only aid in handling the rope, they also serve to avoid damage when properly used.

Hoisting System Calculations

Examples will best discover the simplicity of hoisting system calculations. In order to avoid lengthy problems for determining the exact effect of drill string buoyancy, hole friction, etc., assume that the maximum hook load is 200,000 lb, and that the rig has an 8-line string-up that needs to be changed to 10 lines. Let us see how the rig will be affected. Two equations are involved. They are:

$$\frac{A}{B} = C \qquad \text{and} \qquad (B + 2)\,C = D$$

In which:

A = Hook load, in pounds.
B = Number of lines in the string-up.
C = Average tension in the lines of the static loaded system, in pounds.
D = Derrick load, in pounds.

$$\frac{200{,}000 \text{ lb}}{8} = 25{,}000 \text{ lb} \qquad (8 + 2)\ 25{,}000 = 250{,}000 \text{ lb}$$

$$\frac{200{,}000 \text{ lb}}{10} = 20{,}000 \text{ lb} \qquad (10 + 2)\ 20{,}000 = 240{,}000 \text{ lb}$$

First, it is evident that the tension in the lines has been reduced by 20 per cent; or saying it another way, if the safety factor was 3, it is now 3.6. Next, the derrick load has been decreased 4 per cent. Further, though the same weight is suspended, the engines, clutches, shafting, chains, brakes, hook, swivel, links and elevators do not have to work so hard to carry out their various functions.

There are some drawbacks to consider before adding lines to your present system. First, if the drum speed remains the same, the rate of hook ascent will be lowered. Next, more line must be pulled onto the drum to obtain the same distance of hook movement. In many cases, this will require radical changes to the moving and cutting program, which a wire rope engineer will have to analyze and prescribe.

Some companies assign safe pulling limits to individual rigs to avoid damage during severe service such as running extremely heavy casing strings, pulling on stuck pipe, etc. These safe pulling limits affect and are affected by the number of lines strung. One method of computing safe pulling limits for both the line and derrick follows. Three equations will serve to illustrate the method. They are:

$$A\,B - C = D, \qquad \frac{D}{E} = F, \text{ and} \qquad F\,(E - 2) = G$$

In which:

A = API capacity rating of the derrick, in pounds.
B = An eccentricity factor, usually 80 per cent.
C = Actual weight of the derrick, in pounds.
D = Actual deadweight hoisting capacity of the derrick, in pounds.
E = Number of lines strung plus two (the fast and dead lines must be considered).
F = Maximum permissible tension in the lines of an E—2 string-up under load.
G = Safe capacity of the derrick with E—2 lines strung.

Assume that the derrick weighs 80,000 lb, has an API capacity rating of 800,000 lb and that it has 8 lines strung.

$$(800{,}000 \times .80) - 80{,}000 = 560{,}000 \text{ lb.}$$

$$\frac{560{,}000}{10} = 56{,}000 \text{ lb maximum allowable single-line load.}$$

$$56{,}000\ (8) = 448{,}000 \text{ lb maximum allowable hook load.}$$

F in the above equations may be used to find the proper size of line and drum and sheave grooves when coupled with the wire line safety factor. Suppose it is desired to have a minimum safety factor of 2 when handling casing: $2 \times 56{,}000 = 112{,}000$ lb = minimum nominal breaking strength of line. On examination of wire rope specifications, our choice in this example is limited to 1¼-in. lines if we desire to load the derrick and line to the limit of the derrick with 8 lines. Even though 1⅛-in. improved plow steel lines with an independent wire rope core meet the breaking strength requirement when new (their nominal breaking strength is 113,000 lb), they may not be able to take it after a period of use. Of course, it may not be possible to approach the derrick limit due to the limitations of other equipment, so for this and other valid reasons, we see lots of line smaller than 1¼-in. safely in use on 800,000-lb derricks. For a more complete and accurate analysis of derrick loadings, reference should be made to API Standard 4 A, API Specifications for Steel Derricks.

Moving and Cutting Programs

Most drilling companies use some system for moving the line through the string-up at a uniform rate and cutting it off as it reaches the end of its safe and economic life. This pre-supposes having reserve line in excess of that required for stringing up. Of course, if the money saved in greater wire line service is exceeded by the cost of moving a large reserve of line between locations, a practical limit is placed on the length of the reserve. The average rotary drilling line purchased nowadays is between 3500 and 4500 ft in length; however, on large rigs working on long-term wells, the

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length may be up to 7500 ft or even longer, and on submersible drilling barges, where no truck hauling is involved.

Method of Finding Minimum Length Required. Multiply the height of derrick in feet by number of lines strung plus two.

Round off answer to the nearest 50, then add number of feet of rope on drum.

Example: Using 176 feet for height of derrick; 8 for number of lines strung; 300 for number of feet of rope on drum at lower pick up.

176 x (8 + 2), or 176 x 10 = 1760; round off to nearest 50,	1750
Add number of feet of rope on drum	300
Minimum length required	2050 ft

This minimum length allows dead line to reach anchor at base of substructure.

Evaluation of wire rope service is made in terms of the foot-pounds of work done; however, due to the magnitude of work performed the common unit used is the ton-mile. The API method of calculating wire rope service, as given in API Recommended Practice 9-B, is the most accurate used. It is the basis for most of the slide-rule type of calculators and tables that are used in the field. Most moving and cutting programs for rotary rigs are based on accurate records of the ton-miles of work a drilling line has performed. The drum end of rotary drilling lines is the end cut off. Cable tool drilling lines are cut off on the tool end.

A close visual inspection should take precedence over the ton-mile record as a very real need for cutting may exist long before the record indicates the need. This policy must be tempered with good judgment and experience. For the first few cuts on a new drilling line, it will not have the appearance of being worn out because it has not passed through the entire system. In this instance it is better to heed the record and make the cut, than to wait and be sorry.

Always keep a close watch on the line from the dead sheave all the way to the drum. If too many ton-miles are allowed to accumulate before a move and cut, it is almost certain that a long cut will have to be made later. Upon examination, it generally turns out that the bad place was over the dead sheave at one time or another. A few scattered broken wires on the drum at lower pick-up should not occasion alarm, but the line should not be allowed to run until wire breaks become numerous or localized in any short section of the system.

A wire rope caliper is useful during inspection in measuring the diameter of the rope where it appears to have "pulled down." This is usually due to core failure. The proper method of using the caliper is shown in Fig. 9.

Ton-mile records no longer apply if the line becomes kinked. Also, there is no way to evaluate an extra hard pull, such as on stuck drill pipe or casing. The record is questionable until all the line between the dead-line anchor and the drum end at the time of the hard pull is removed from the system. This can be partially offset by arbitrarily adding 200 or 300 ton-miles to the record at the time of the pull, but there is no assurance that this will remedy the situation.

FIG. 9. A SAMPLE TON-MILE RECORD FORM.

ROTARY DRILLING LINE SERVICE RECORD

SHEET ______ OF ______ SHEETS

COMPANY ______ WELL AND NO. ______ RIG NO. ______ MAKE AND TYPE DWKS. ______

DRUM DIAM. ______ PLAIN OR GROOVED DRUM ______ CROWN BLOCK SHEAVE DIAM. ______ TRAVELING BLOCK SHEAVE DIAM. ______ WT. OF TRAVELING BLOCK ASSEMBLY (FACTOR "M") ______ SIZE AND WT. DRILL PIPE ______

MAKE OF LINE ______ SIZE AND LENGTH ______ CONSTRUCTION ______ GRADE ______ REEL NO. ______

DATE LINE PUT INTO SERVICE ______ DATE LINE RETIRED FROM SERVICE ______ NO. LINES STRUNG ______ INITIAL | 1ST CHANGE | 2ND CHANGE — WELL DEPTH WHEN STRING-UP INCREASED ______ 1ST CHANGE | 2ND CHANGE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
						Drill Collars											
Date	Trip No.	Depth of Trip	Operation to be Performed & Remarks	Mud Weight lb. per gal.	Effective Wt. of Pipe, Fig. 29A	O. D. and Bore	Effective Wt., Ec Fig. 29B	Excess Wt (Col. 8 Minus Col. 6)	No. of Feet	Factor C (Col. 9 x Col. 10)	Factor M+½C	Ton-Miles Service This Operation Fig. 30	Cumulative Ton-Miles Since Last Slip	Length Line Slipped, ft.	Cumulative Ton-Miles Since Last Cutoff	Length Line Cut Off, ft.	Length Line Remaining, ft.

TON-MILES SERVICE — PREVIOUS WELLS ______ TON-MILES SERVICE ON TRIPS — THIS WELL ______ TON-MILES SERVICE DRILLING — THIS WELL ______ TON-MILES SERVICE CORING — THIS WELL ______ TON-MILES SERVICE SETTING CASING — THIS WELL ______

TOTAL TON-MILES SERVICE — ALL WELLS ______ TON-MILES PER FT. OF INITIAL LENGTH ______

Directions for filling out this form, including use of charts, are given in the instruction sheets included with each pad, and are also given in API RP 9B, Recommended Practice on Application, Care and Use of Wire Rope for Oil-Field Service.

Courtesy American Petroleum Institute

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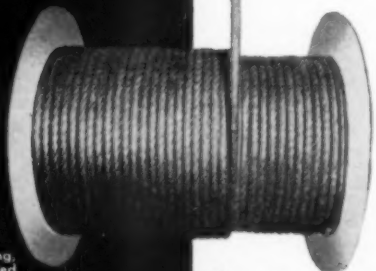
Drilling Fundamentals

. . . and be sure "she's LeBus Spooled"

LEBUS GROOVING & COUNTERBALANCED SPOOLING SYSTEMS...

- Allow faster speed for operation of drilling hoists.
- Allow up to 40% deeper drilling with your present rig.
- Are saving over *$600 per rig monthly in wire line and operating time alone (*Average based on records of 2,500 rigs.)
- Eliminate drum and drawworks vibration formerly caused by bad spooling.
- Eliminate wire line whip between drum and crown.
- Insure greater safety to crew.
- Eliminate hand spooling of line.



Patent Nos.: Counterbalanced Spooling, Nos. 2,734,695; 2,732,150. Controlled Parallel and Helical Spooling, Nos. 2,708,080; 2,620,996. Appli. of grooving, Nos. 2,599,926; 2,204,938. Removable End Fillers, No. 2,216,819. Other patents pending.

"She's LeBus Spooled" is a common expression these days around the oil patch for LEBUS GROOVING AND COUNTERBALANCED WIRE LINE SPOOLING SYSTEMS.

Fully patented, the LEBUS SPOOLING SYSTEMS are now used on over 2500 rigs. Savings of over 18 million dollars yearly are being enjoyed in wire line and drilling time alone!

The LEBUS NEW COUNTERBALANCED SYSTEM is the latest advancement — further reducing the whipping action of the line... adding more to its life . . . and allows the line to be spooled at even faster speeds than ever before possible.

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LEBUS **LeBus International Engineers**

Executive Offices and Warehouse
Longview, Texas

Possibly, the rule most universally agreed to by wire rope engineers and rotary drilling people is that the moving and cutting program must be tailored to the individual rig. Beyond this point, methods of determining the economic and safe service life of a line, and the length and frequency of cut vary widely. The principal idea is to choose some goal for service in terms of ton-miles per foot of line and devise a method for reaching the goal. One such method is herewith presented as an example.

For purposes of analysis, assume that a 4500-ft line has been purchased, of which 1500 ft is required for the string-up, and that it is desired to obtain 15 ton-miles per foot of the reserve line. Further, assume that upon observation it has been determined that an accumulation of approximately 1000 ton-miles between cuts and slipping at intervals of about 500 ton-miles is practical, safe, and economical. This method of determining slipping and cutting lengths is as follows:

4500 ft — 1500 ft = 3000 ft of reserve line.

15 T-M × 3000 ft = 45,000 T-M service. (In this case, 10 T-M per foot of total line equals 15 T-M per foot of reserve line.

$\frac{500}{15} = 33.3$ ft per slip $\qquad \frac{1000}{15} = 66.7$ ft per cut

$\frac{3000 \text{ ft}}{66.7 \text{ ft}} = 45$ cuts should be made

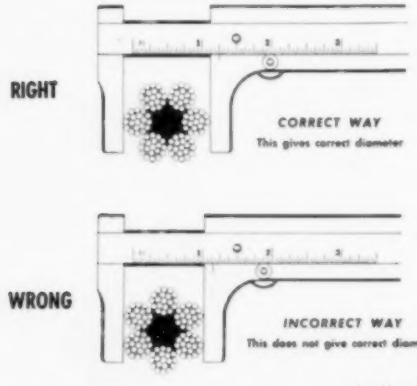
Since ton-miles do not accumulate in lots of 500, this is how it works in service.

$\frac{520}{15} = 34.7$ ft on *this* slip. $\qquad \frac{969}{15} = 64.6$ ft on *this* cut.

If the above procedure is followed and nothing occurs that requires a radically out-of-schedule or unduly long cut, it should be possible to reach the goal without difficulty. After trying this method for awhile, if it is found by close wire line inspection that the goal is too high or low, it should be altered in small increments until the proper goal is found.

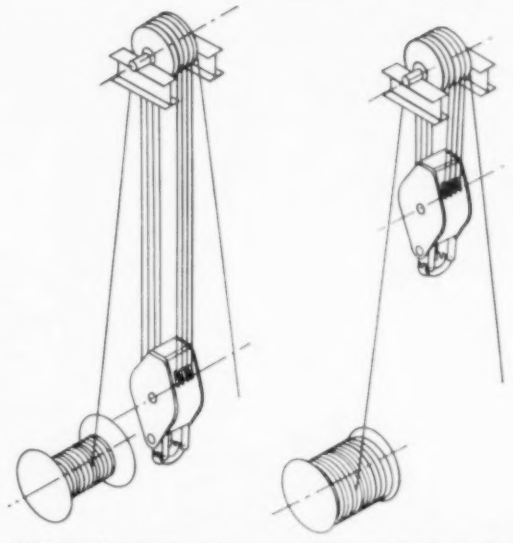
Whatever method of determining slipping and cutting lengths is used, it is most important to see that the length slipped does not place any part of the line in a position of severe wear a second time. These points of severe wear are the parts of the line over any sheave at either the upper or lower pick up (see Fig. 10) and the places where succeeding wraps cross over those beneath on the drum. It is worthy of repetition that visual inspection should be more important in determining time to cut than the ton-mile record, but when the record says cut, don't wait, do it now.

Wire line is a very controversial subject in the oil fields.



American Steel & Wire

FIG. 10. Right and wrong way to caliper wire rope.



Union Wire Rope

FIG. 11. Spooling conditions on the drum vary with block in up-and-down positions.

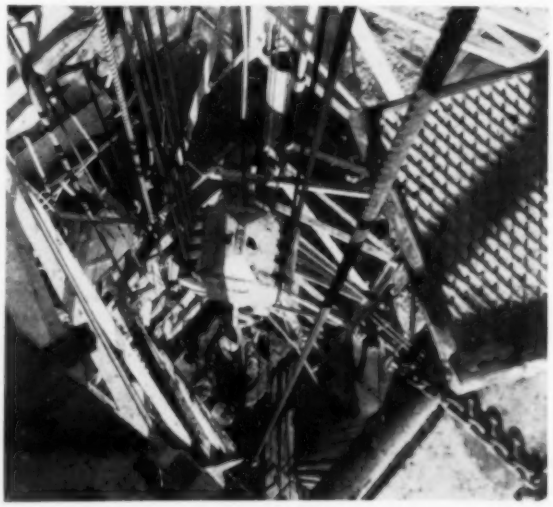


FIG. 12. Good practices and maintenance of wire rope are essential. The lives of the men on the floor depend on its strength.

It is difficult to discuss very long without stepping on someone's toes or crossing some company's policy. It is sincerely hoped that this discussion is objective enough to avoid this. One policy on which all can agree is that every move an engineer makes with regard to the wire line program on his rigs should first consider the men who work on the rig floor beneath all that "iron."

References

1. API Standard 4A: Specifications for Steel Derricks (Including Standard Rigs), API Division of Production, Dallas, Texas.
2. API RP9B: Recommended Practices on Application, Care and Use of Wire Rope for Oil Field Service, API Division of Production, Dallas, Texas.
3. Wire Rope Engineering Handbooks — published by: A. J. Roebling's Sons Division of Colorado Fuel and Iron Corporation, American Steel and Wire Division of U. S. Steel Corporation, Union Wire Rope Corporation.
4. The Care and Use of Wire Rope: An API vocational course developed by the University of Oklahoma, Norman, Oklahoma.
5. Wire Rope Data and Tables — Oil Fields — published by Wire Rope Corporation of America, Inc.
6. Wire Rope Is a Machine — published by Jones & Laughlin Steel Corporation.

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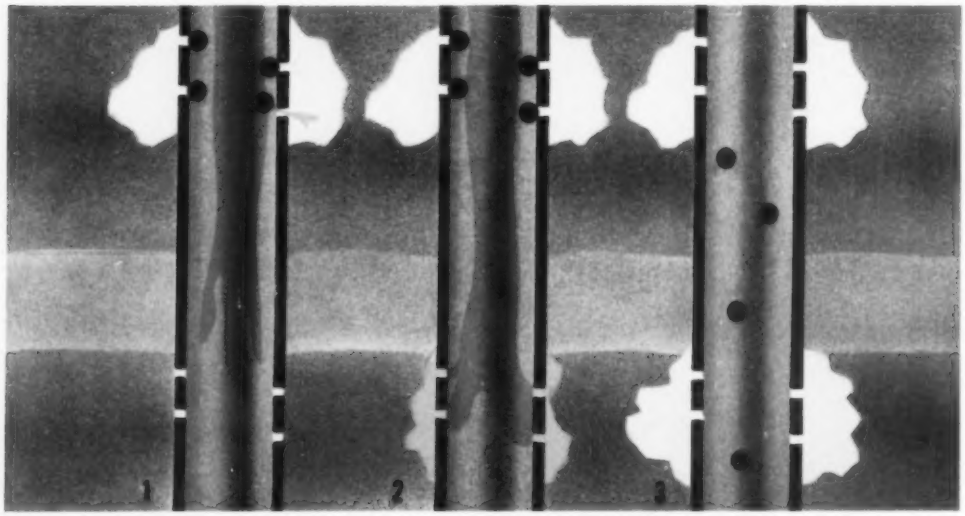
Proved Performance with Perforation Ball Sealers.....

- **In more than 450 wells throughout the Southwest**
- **In all types of formations**
- **When used with all types of fracturing and acidizing fluids—from fresh water to lowest gravity lease crudes**
- **With all types of perforations, bullets and jet**
- **Under all well conditions—multiple and single zone**
- **In wells with 10 feet of perforations to 400 feet of perforations**
- **Using as few as 20 balls and as many as 1,000**

Perforation Ball Sealers—introduced by The Western Company only a few months ago—have proved the most effective, yet simple, means of bringing complete treatment to the entire perforated section on one set-up. Their ball-valve action temporarily seals off perforations opposite the most permeable zone,* diverting treating fluids into the tighter zones to insure complete break-down and treatment of the entire section.

Ball Sealers cut to a minimum the use of down-hole tools and reduce pressure differential across the cement blanks. They allow break-down of the entire perforated section with greatest economy, whether only 10 feet in length or several hundred, single or multiple zones, close together or widely separated. Treatment control is provided even in cases where no other control mechanism can be used.

* Sealing action and self-removal from perforations verified by Pittsburgh Testing Laboratory. Details on request.



1. Perforation Ball Sealers seal perforations opposite zone that is fully treated, diverting fluid into other perforated section.
2. Break-down and treatment of less permeable zone is completed as balls give positive seal on upper zone.
3. Pressure is reversed and balls drop from perforations to bottom of the well to be left or recovered by bailer if desired.

PERFORATION BALL SEALERS GIVE EFFECTIVE TREATMENTS—

Effectiveness of treatments using Perforation Ball Sealers is proved by radioactivity tracer logs run in many wells. Complete break-down and treatment of the entire perforated section on a single set-up provides the most effective treatment for greatest results.

Here are a few examples of Perforation Ball Sealer effectiveness:

Location County	Formation	Perforations	Sealers	Previous Production	Present Potential	Offset Potential*
Andrews, Texas	San Andres	6 sets total 118 ft.	375	13 BOPD pumping	120 BOPD flowing	50 BOPD pumping
Crane, Texas	Dune Grayburg	1 set total 100 ft.	444	new well	400 BOPD flowing	100 BOPD pumping
Stephens, Okla.	Tussey Woodmansee	4 sets total 84 ft.	250	new well	2044 BOPD	300 BOPD
Carter, Okla.	Tussey	2 sets total 40 ft.	300	48 BOPD pumping	604 BOPD flg. & ppg.	50 BOPD pumping
Carson, Texas	Wolfcamp Dolomite	4 sets total 47 ft.	315	new well	432 BOPD	336 BOPD
Hutchinson, Texas	Wolfcamp Dolomite	2 sets total 64 ft.	240	new well	105 BOPD pumping	72 BOPD pumping

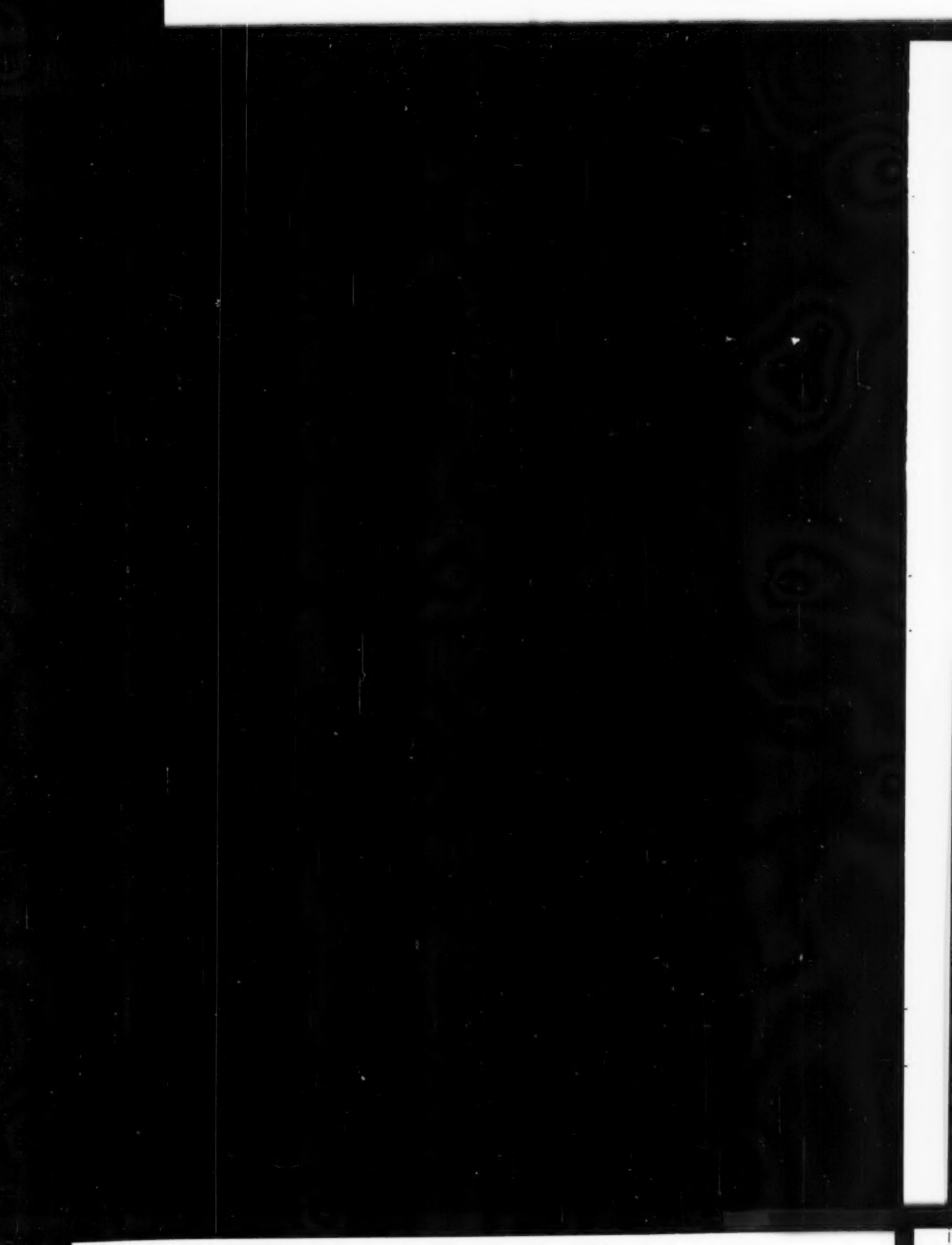
* "Offset Potential" is from offset wells completed in the same formations, with substantially the same number of perforations and intervals, and treated using conventional fracturing methods without Ball Sealer control.

PERFORATION BALL SEALERS MEAN ECONOMY—

Fracturing and acidizing treatments using Perforation Ball Sealers have resulted consistently in savings of several thousand dollars per well in treatment costs. Following is a comparison of completion costs of wells for one operator in the same field in Winkler County, Texas. Wells in black were treated by conventional methods, involving use of packers and stage treatments. Those in red were completed with Ball Sealers. Wells averaged nine perforated intervals in the same formation.

	Well No.	Perforating	Total Treatment Cost	Rig Time	Packer Rental	Misc. Cost	Total Cost
Conventional	1	$1,174.00	$14,984.00	$10,065.00	$4,056.00	$3,799.00	$34,078.00
	2	2,878.00	12,721.00	4,522.00	1,360.00	1,126.00	24,115.00
	3	2,564.00	11,134.00	2,633.00	1,930.00	2,547.00	20,808.00
Ball Sealers	4	2,447.00	9,025.00	500.00	0.00	350.00	15,107.00
	5	2,345.00	7,740.00	725.00	0.00	700.00	10,500.00
	6	1,246.00	5,035.00	500.00	0.00	750.00	7,551.00

Western Engineers can supply you with case histories for virtually any production area in the Southwest, showing both the economy and effectiveness of Ball Sealer controlled treatments.



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Complete!
Economical!

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Treatments

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WELL SERVICES

To get the fullest advantages of Perforation Ball Sealer treatments, pinpoint the pay zones accurately with Western's Gammatron radioactivity logging. Instrumentation by Scintillation Counter, Ionization Chamber and Geiger Counter provides the finest detailed radioactivity logs available.

You can INTEGRATE your well completion or remedial program with Western's engineered well services—Gammatron logging, jet perforating, fracturing and acidizing—for greatest results.

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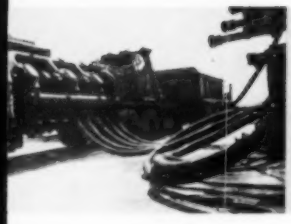

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P 500.

Natural Gas Processing by . . .

Low Temperature Separation

Conditions that plagued the industry with hydrate blocks in gas lines are utilized to condition gas and capture higher distillate recovery on the lease

Jack L. Wiggins
Petroleum Consultant, Austin, Texas

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Basically, the cold separation unit being used in gas fields today may be thought of as a combination of devices. The entire process of cold separation rests on the characteristics of gas: (1) The cooling or refrigerating effect which occurs when gas is forced through an orifice; (2) the formation of hydrates that occurs when some hydrocarbon gases are mixed with water and agitated under certain temperatures and pressures, and (3) the inclination of liquid hydrocarbons and water vapors to condense and fall out of the gas stream when it becomes colder.

These three gas characteristics are exploited in all devices used in cold separation processes.

It follows that a gas with certain characteristics must be available at the well if a cold or lower temperature separation unit is to be self-operating. It must have enough well-heat to melt the hydrates that are formed and must have enough initial well pressure to produce sufficient cooling, when pressure is reduced, to lower the temperature of the gas stream to a hydrate forming point.

Most authorities on the subject recommend that a pressure drop of around 1200-lb be available. In other words, if the well pressure is 3000 psi, then the gas gathering line pressure should not be higher than 1800. Degree of pressure is not so important for sufficient refrigeration as is the difference in pressure.

If the well has neither of these characteristics, then artificial heat must be added to replace that normally required, and artificial refrigeration must replace that which would have been produced by throttling the gas.

Since liquid in a gas condenses as the gas becomes colder, it has been a feature in some cold separation units to operate the unit at the lowest temperature possible, thereby condensing the maximum amount of hydrocarbon liquids from the gas, and increasing hydrocarbon recovery in addition to the reduction of water content. In this type of cold separation units certain hydrate inhibitors such as the glycols are added to the gas just upstream of the choke, and the glycol inhibitor prevents the formation of hydrates. Separation of liquids from the gas is accomplished by the extremely low temperatures in the expansion chamber. The

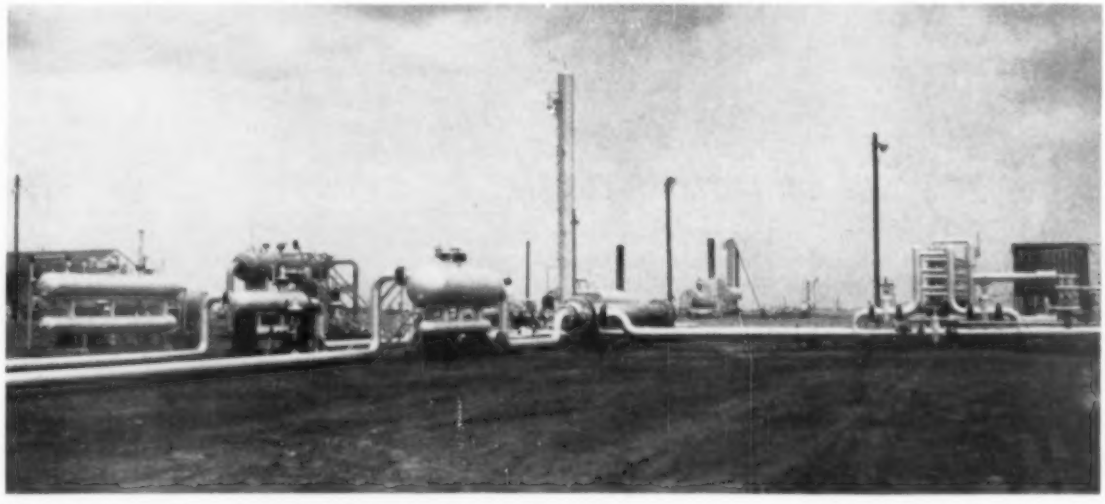
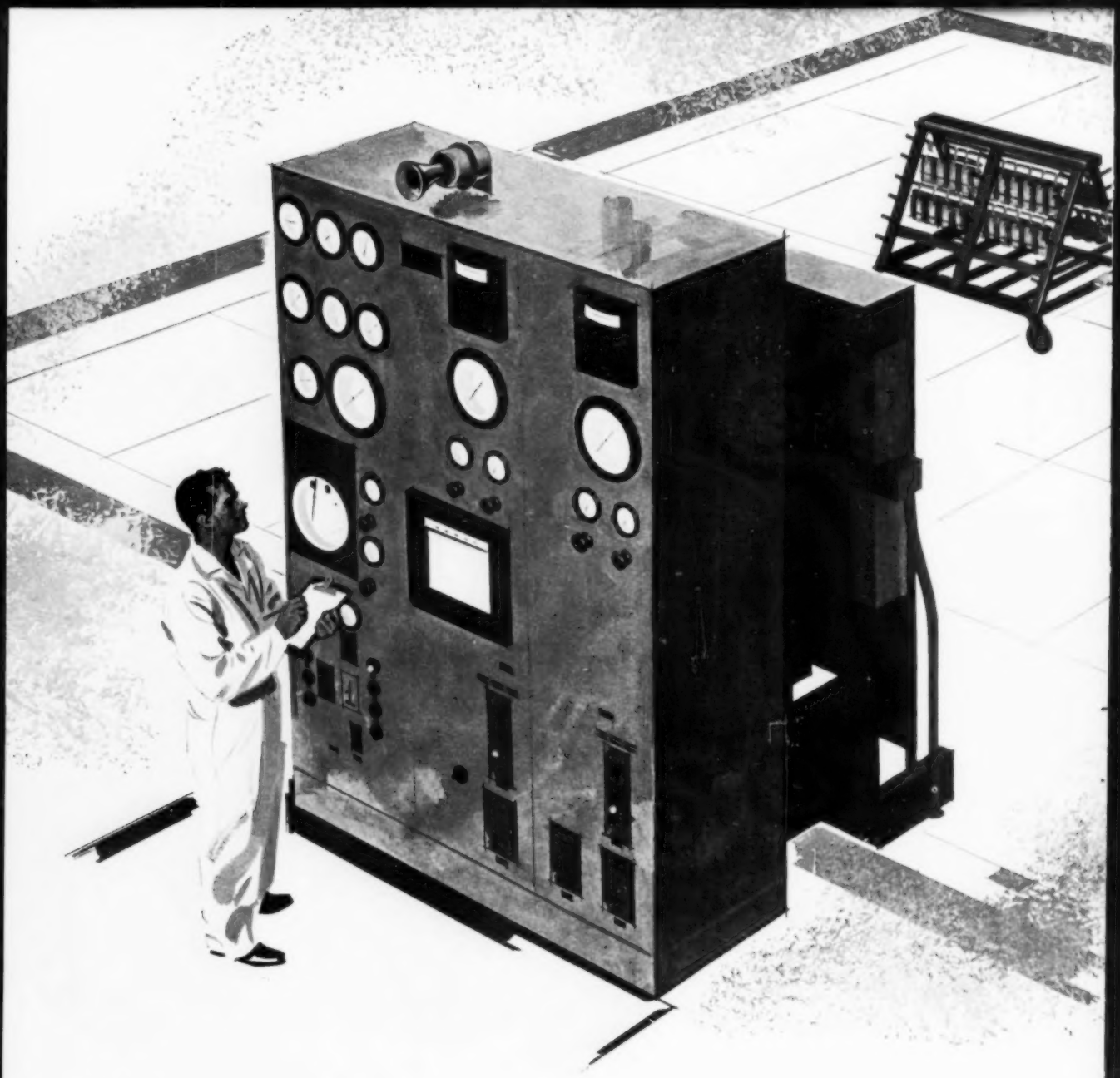


FIG. 1. A cold separation unit near Freer in Southwest Texas. Glycol unit may be identified by its fin-tipped tower. Large central tower is the product stabilizer. *(Courtesy, Black Sivalls & Bryson, Kansas City)*



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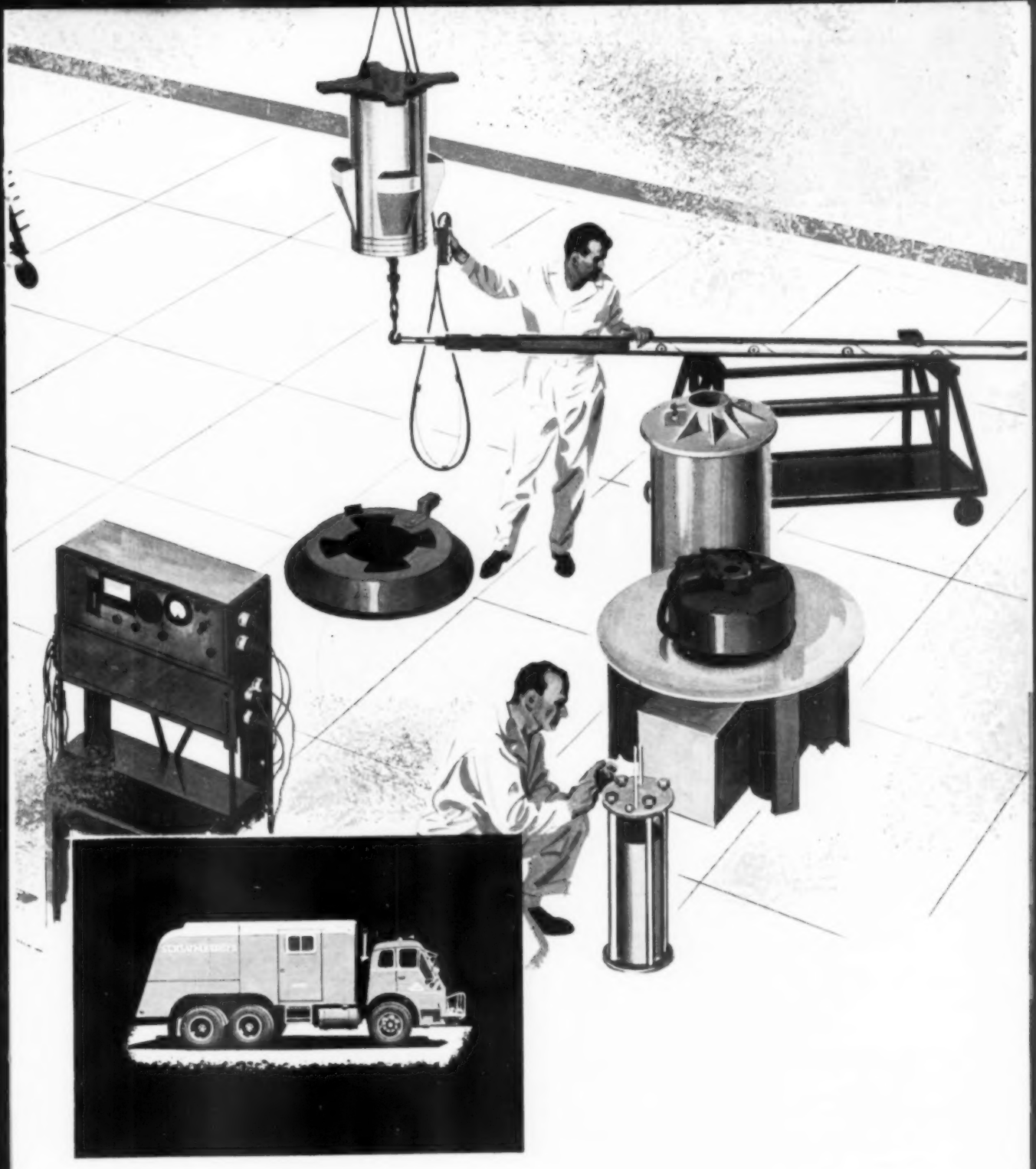

Schlumberger...to be sure!

glycol and hydrocarbon liquids are then carried off and separated, and water is removed from the glycol by refrigeration.

Regardless of the method employed, certain chambers and devices are common to them all. All employ a choke to restrict the flow of gas, to reduce its pressure, and refrigerate the gas. All types employ a refrigeration chamber in which either hydrates or liquids condense out of the gas stream. All units employ heat exchangers and liquid gathering and separating tanks, which are equipped with automatic level controllers and dump valves.

Components employed in the low temperature separation units include: a gas scrubber, high-pressure liquid knock-out, jacketed choke, hydrate melting chamber, heat exchanger, and expansion chamber.

The Scrubber

The scrubber is not required in all installations. It is desirable equipment on wells that continue to blow sand or mud from the formation, and it prevents many problems of clogged instruments and cut valves. The scrubber is designed to catch much of the solid particles that otherwise would pass to the separation unit and through the choke and orifice plates.

High Pressure Liquid Knockout

The liquid knockout is designed to remove all free water and distillate from the gas stream. Gas from the well loses some of its heat as it flows through the scrubber. Liquid hydrocarbons which were in the vapor state in the gas at the bottom of the hole may condense because of temperature and pressure changes. These condensed vapors will be water or liquid hydrocarbons. The knockout is a simple combination of two vessels which, like the scrubber, decrease the velocity of the gas stream and allow heavier particles of liquid to fall and collect in the lower vessel.

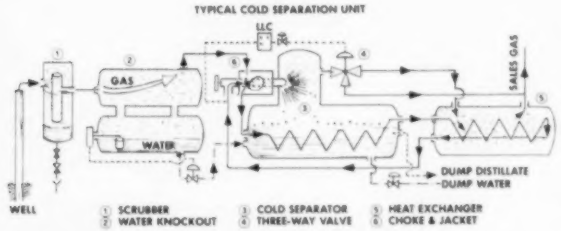

FIG. 2. Typical cold separation unit provides several steps in gas processing from the wellhead to final sales gas product.

The Cold Separator

The unit which actually separates liquid from gas by the formation of hydrates may be called the cold separator. This unit is designed to accomplish several tasks.

First, it has an expansion chamber into which the well gas is discharged after leaving the choke. This expansion may cool 85 F gas at 3000 psi down to 22 F at about 900 lb. A rule of thumb for judging temperature drop is as follows: For each 100 psi decrease of pressure there will be about 3 deg drop in temperature on the Fahrenheit scale.

Second, there is a hydrate melting chamber, containing warm liquid and heated with coils filled with warm well-gas.

Third, the cold separator is fitted with baffles and liquid level controls which act to separate distillate from water. Fig. 3 illustrates how these fnuctions are accomplished.

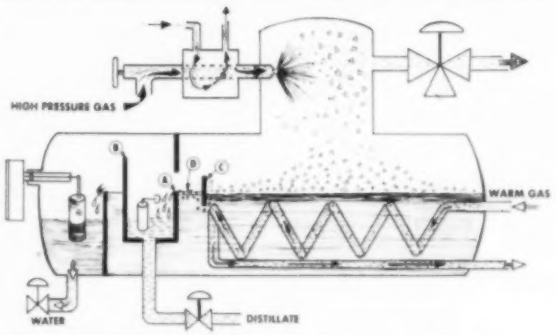

FIG. 3. Cold separator in the system collects and melts hydrates formed in expanding gas and separates the distillate and water.

Since a hydrate crystal is composed mainly of water, only a small part of the crystal changes into distillate (liquid hydrocarbon). This hydrocarbon liquid floats on top of the water. An attempt is usually made to draw it off before it increases its temperature and begins to take on water particles. Most cold separators are designed so that baffles will not permit more than a thin layer of distillate to collect over the water.

Low Temperature Systems

Recent developments have resulted in the use of equipment in which the formation of hydrates is purposely prevented by the injection of hydrate inhibitors such as diethylene glycol. This inhibitor permits the temperature of gas to be lowered greatly without the formation of hydrates, and since most experts agree that liquid recovery increases with lower temperatures, this development is considered an improvement in some instances over the cold separation unit which must operate at not more than a few degrees above hydrate forming points.

If the hydrate-forming method of separation is changed over to the glycol method, several devices are added to it: (1) Glycol pumps, (2) Heater, (3) A low-pressure separator, and (4) A glycol reboiler. This system sometimes results in the loss of many vapors from distillate which had been collected, and units are now being equipped with another piece of equipment called the stabilizer, which prevents vapor losses in the low-pressure separator. Each of these will be considered separately. Fig. 4 shows the conventional hydrate-forming unit converted to a glycol unit without the stabilizer. Fig. 5 shows the stabilizer added.

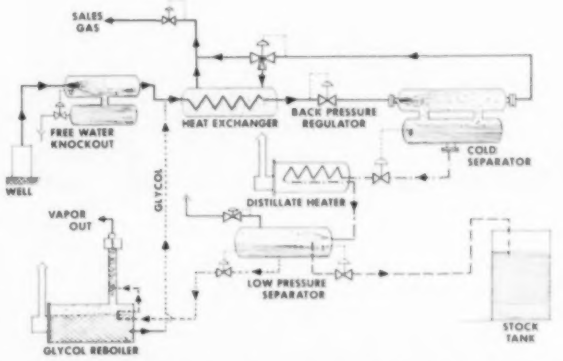

FIG. 4. Typical glycol system permits the use of lower temperatures in the separation process and normally provides greater yields.

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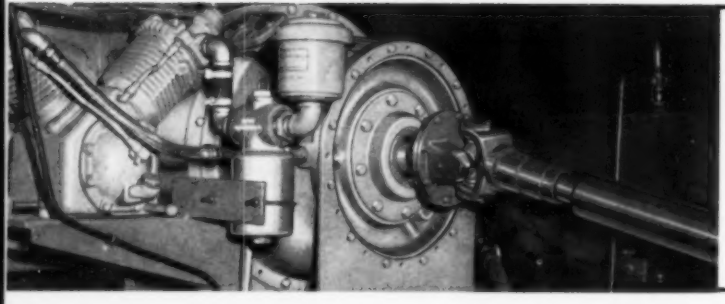
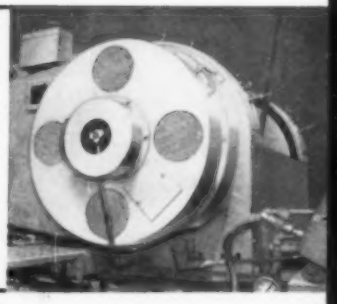


Transmission

An Allison Torqmatic Transmission provides 3 speeds forward and reverse to vehicle and also to hoisting drums.

Friction clutches

All friction clutches are air actuated. Outboard mounting provides easy accessibility when servicing is required.



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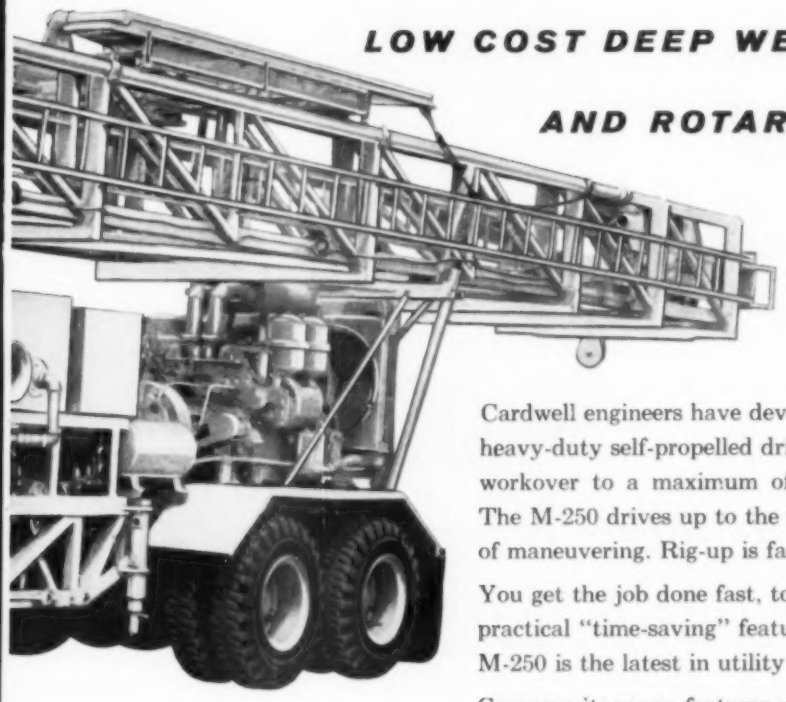

Cardwell engineers have developed this truly versatile heavy-duty self-propelled drive-in rig for servicing and workover to a maximum of 13,000-feet, with 2½" tubing. The M-250 drives up to the well head and with a minimum of maneuvering. Rig-up is fast for servicing operations.

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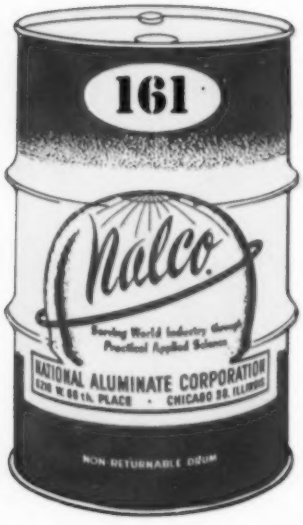

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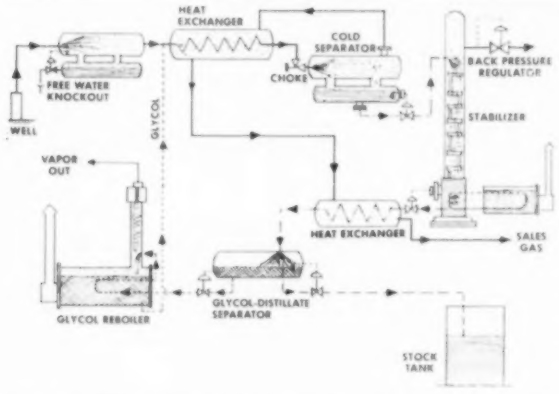

FIG. 5. Typical glycol separation system equipped with stabilizer. Stabilizer has the effect of separating or eliminating lighter hydrocarbons which could not be retained at atmospheric temperatures.

The Glycol System

Every liquid has a different freezing and boiling point. Certain glycols such as diethylene glycol, freeze at points many degrees below the freezing point of water, yet glycol does not boil until it reaches a temperature well above the boiling point of water. Diethylene glycol will absorb water readily, therefore it serves two purposes in a glycol unit. It prevents the formation of gas hydrates by mixing with water molecules in the gas, and removes water from the gas stream.

Under some conditions the temperature may be brought many degrees below zero Fahrenheit, but since temperatures of minus 20 deg reduce the strength of carbon steel considerably, units would not be expected to operate at lower temperatures unless constructed of special alloy steels.

The gas stream flows from the well to a free water knockout. The well gas loses little of its heat until it leaves the knockout and enters the heat exchanger where cold gas from the cold separator surrounds coils carrying the incoming gas. Glycol is added to the gas stream. Pre-cooling enables the gas to enter the cold separation unit at a temperature below the hydrate forming point. Expansion of the gas through a choke into the cold chamber drops the temperature as much as 75 deg with a 2000 lb pressure change. The sudden decrease in temperature condenses the water and glycol distillate particles, and they are collected in the lower vessel.

This mixture of glycol, water, and distillate which is under pressure of from 800 to 1500 lb, is then passed to a heater. There its temperature is raised, allowing some of the light hydrocarbon gases to escape from the solution. This gas-liquid mixture is flashed to a low-pressure separator. Pressure reduction allows gases to come out of the liquid, and these gases are vented to the air.

The remaining liquid settles in two layers in the lower part of the separator. Water and glycol settle to the bottom and a layer of distillate floats on top. Liquid level controllers regulate the dumping of the respective fluids, distillate being diverted to the stock tank, and glycol-water to the reboiler for regeneration. There it is heated to approximately 250 F, boiling off the water. Dry glycol is pumped from the reboiler with a high-pressure gas-driver pump, which forces the glycol into the well stream duct below the water knockout.

When distillate is flashed into the low pressure separator and again into the stock tanks considerable amounts of liquid distillate may be lost as a vapor to the atmosphere. In some installations it is profitable to install a stabilizer between the high and low pressure separator.

The Stabilizer

Stabilization, once entirely a gasoline plant operation, has in the past few years been brought to the field in connection with cold separation. Losses of vapors coincident with stage separation was always appreciable when liquid stock was flashed to lease tanks. If this flashing could be prevented, a two-fold saving could be expected: First, the saving of light and valuable vapors which increased the gravity of the distillate, and second, the retention of heavier components of the liquid that were carried out of solution with rapidly moving lighter vapors, thereby actually depleting the liquid stock.

Two types of stabilizers have been employed in field operation. The earliest type consisted of a tower, an accumulator, a condenser, a pump, and other devices for catching vapors, condensing them to a liquid, then recycling them through the tower.

More recently, with the employment of the glycol injection method of cold separation, there has come into use the old "cold feed" internal reflux system, and the accumulator, condenser and pump have been eliminated. The tower is also smaller. The basic difference between the two systems is the temperature at which the glycol-water-distillate stream is fed into the tower. In a glycol system, the stream is colder at all points, and especially at the point of feed into the stabilizer. Also, the cold feed stabilizer operates under pressure, a constant pressure being held on the tower by a back pressure valve on the vapor outlet line.

In the stabilizer tower, liquid flows down through the bubble trays to the bottom. There it is heated by coils containing steam or through coils immersed in a salt bath heater. This heating drives off lighter vapors and they rise up through the tower, contacting the incoming cold liquid as it falls. Since the temperature increases as the bottom of the tower is approached, the lighter liquids vaporize as they move downward. The heavy liquids that reach the bottom tray may yet contain more light vapors, and in order to dispel these, that liquid is heated by passing it around steam coils or through the salt bath, thereby vaporizing its lighter parts. The remaining liquid is passed through a heat-exchanger and cooled by the cold sales gas that has just left the cold separator. The liquid then passes to a glycol-distillate separator where the separated distillate is dumped into stock tanks, while the glycol-water mixture is sent to the glycol reboiler. Distillate placed in the stock tanks flashes very little, since all its light vapors have been removed and its temperature is about that of the atmosphere.

The glycol reboiler maintains a temperature of around 250 F. Water is dispelled in the form of steam, leaving the pure lean glycol for reuse.

More Efficient Operations

The addition of hydrate inhibitors and stabilizers in cold separation systems have increased the efficiency of field installations in many instances by more than 50 per cent. The valuable light ends of hydrocarbon gases are being stripped in the field rather than being wasted, and stock tank losses in gravity and volume are lessened. Many variations of the basic equipment mentioned in this article are being employed, and many refinements are in progress. The remarkable progress of the industry within the past two decades toward the prevention of waste, and the conservation of natural resources establishes a very commendable achievement.

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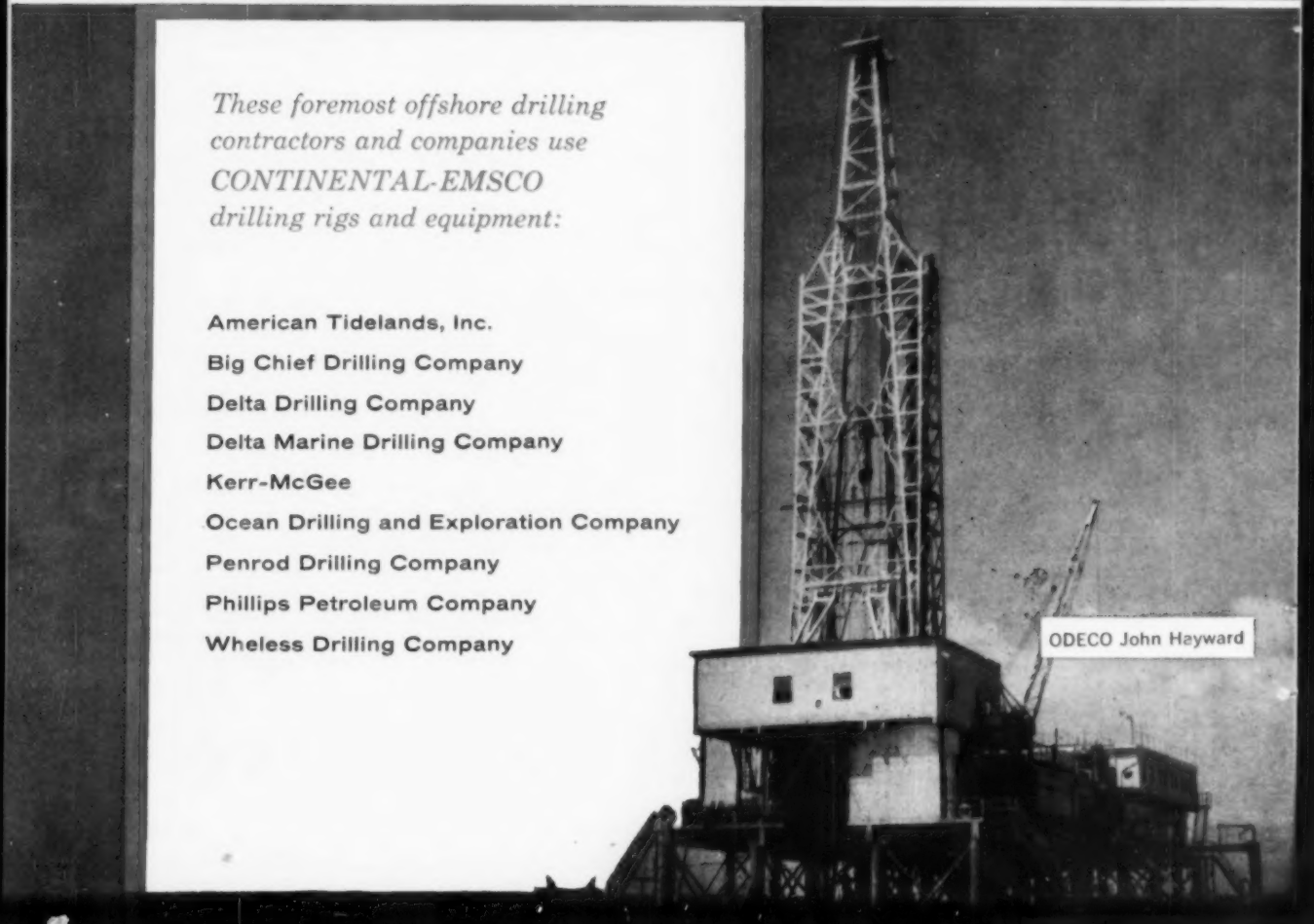

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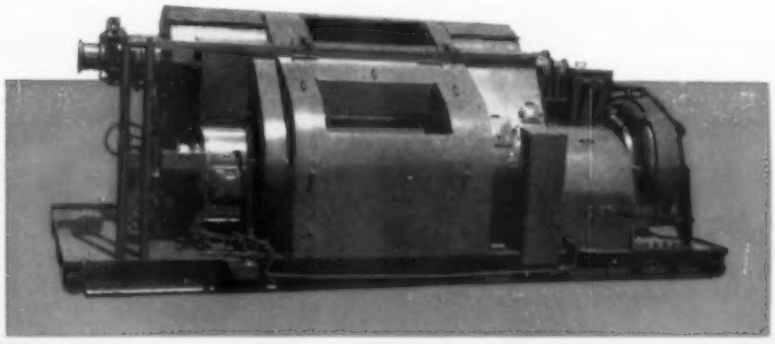

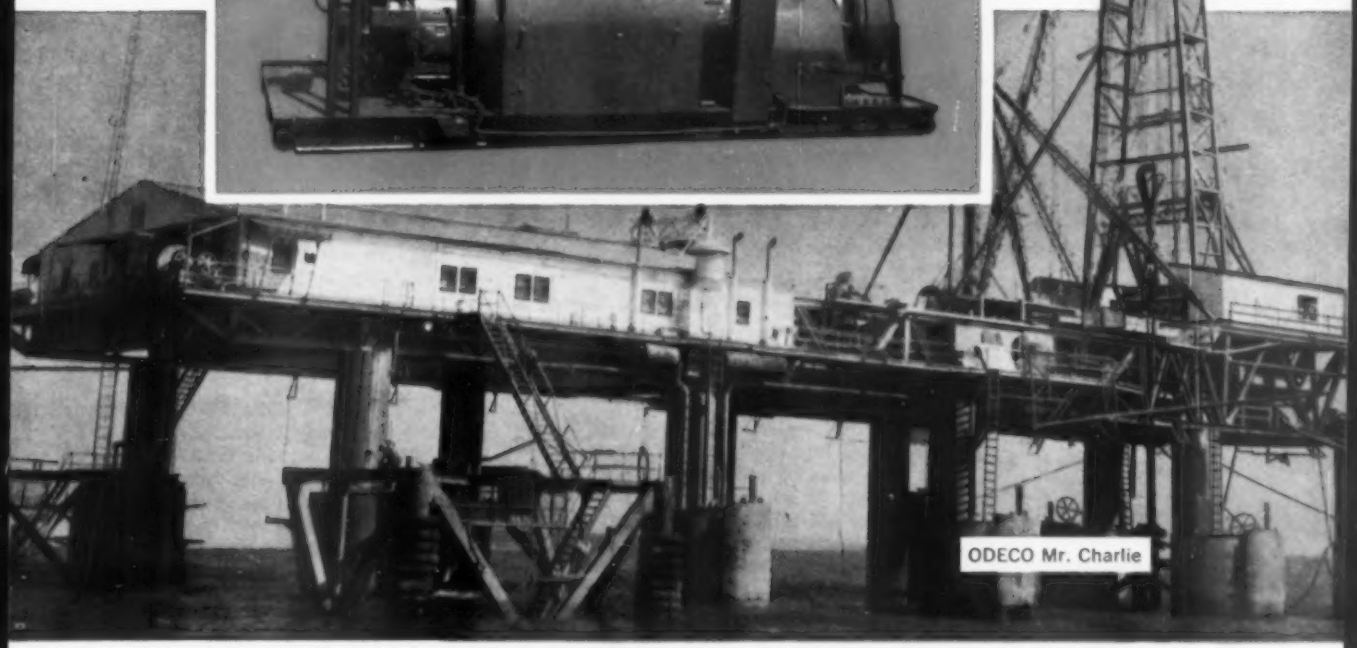

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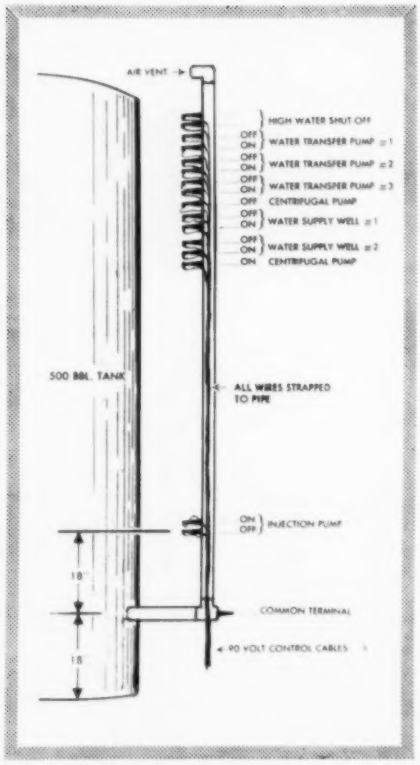

FIG. 1. **Electrode arrangement diagram** on the Cochran & Cain injection system. Any water level fluctuation acts to break circuits installed on this water column. Electric cables are enclosed in a metal raceway.

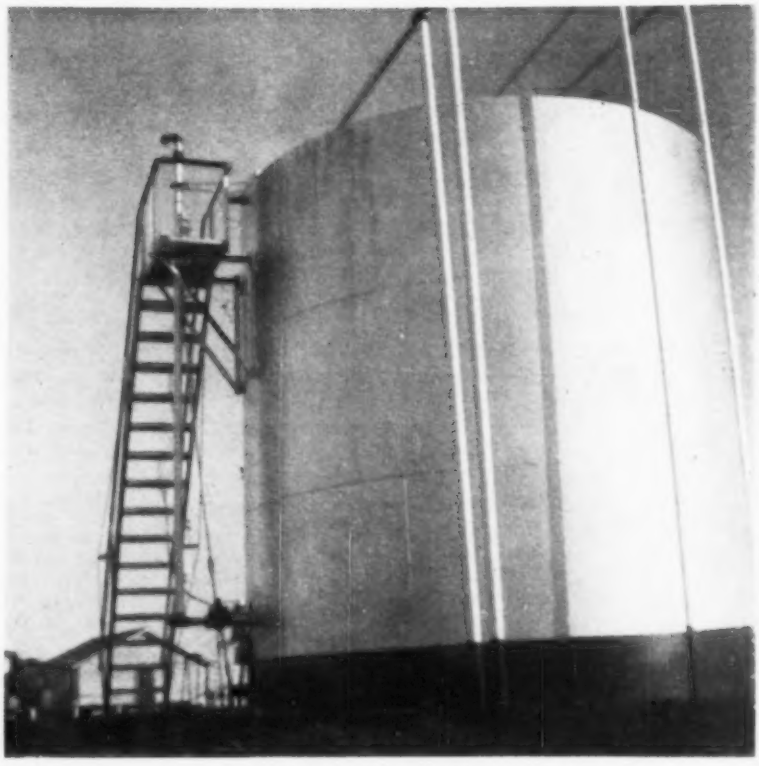

FIG. 2. **This 500 bbl water storage tank** controls injection into 38 wells and flow from three water producing wells. Injection station is shown in the background.

— Photos courtesy Texas Electric Service Company

Electrodes in water leg of reservoir tanks are heart of...

Complete Automation In Water Injection

Injection into 38 wells controlled entirely by simple but unique electrical system

R. H. Travis
Texas Electric Service Company, Wichita Falls, Texas

A UNIQUE system for control of water production, transfer, and injection has been devised by an independent oil producer in North Texas. This system, employed by T. B. Cochran and Wofford Cain of Dallas, is in operation on a 600-acre waterflood project in Archer County, Texas.

This system was designed to gain two major advantages over the conventional float-switch type of control: (1) Reduce the labor required to operate the system, and (2) reduce maintenance costs to the bare minimum. These twin goals were achieved, with a corollary advantage of reduced cost of installation of this system over the conventional type.

"Circuit-Breaker" System

The system consists basically of a series of electrodes so arranged that when the produced water level in a central tank rises or falls, it closes or opens electric circuits, with the water serving as the conductor to make or break the circuit. In turn, the circuit closed or opened by variation in water level causes a relay to operate, thus controlling an electric motor somewhere in the system.

This project has 58 producing wells and 38 injection wells, the production being from the Thomas sand at an approximate depth of 1200 ft. Water is injected at the rate of 2200 bbl per day at a pressure of 800 psi. Injection

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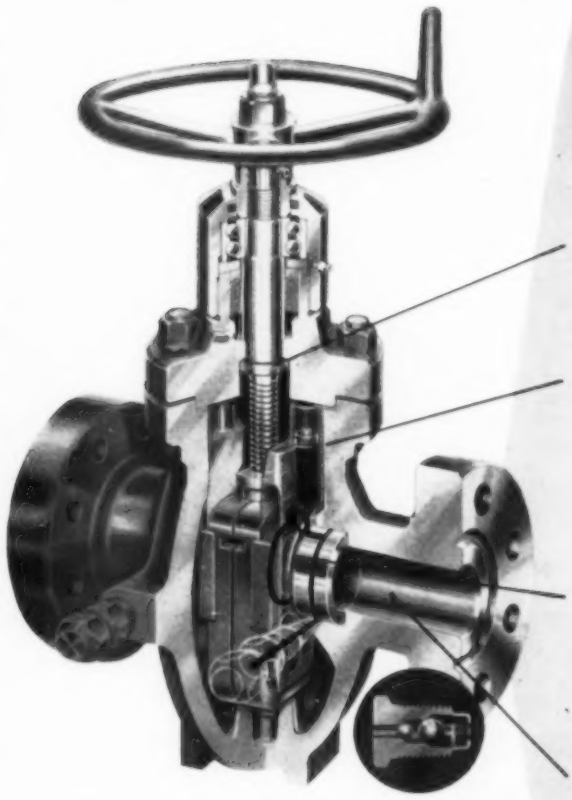

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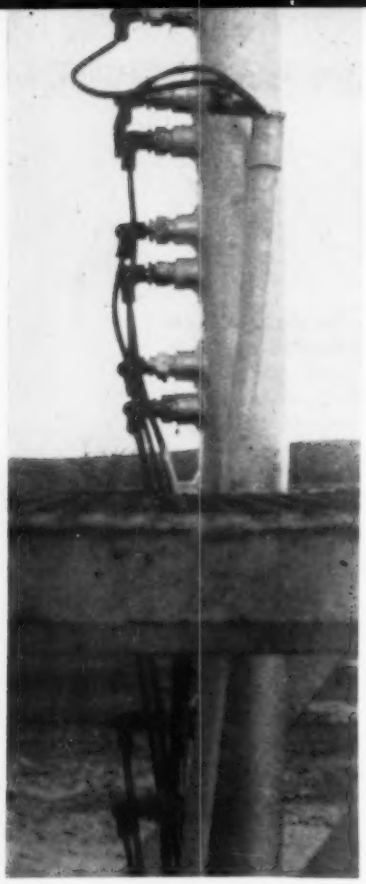


FIG. 3. **Electrodes on the water leg** on the 500 bbl storage tank are 90-v control cables. Top electrode here is the high water shut-off, stopping all water production and water movement to the storage tank.

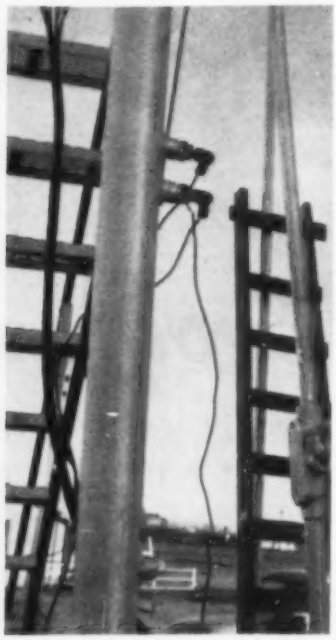
water is produced by three wells from 1550 ft. The project was started as a pilot operation in June, 1955, and reached full development in August, 1956. It is currently producing some 500 bbl of oil per day, and should reach its peak of some 700 bbl of oil per day in February, 1958. This project has an expected life of some nine years, and the operator evaluates the results thus far attained as excellent.

Supply, Demand Control

This project uses a closed water system. Two water wells are equipped with 20 hp and 15 hp electric motors on conventional beam units. The third well is equipped with a 42 multi-stage centrifugal pump and is used only when the other two wells cannot produce fast enough. Additional water produced with the oil is transferred into the injection system, using 3 hp transfer pumps. The system uses a 60 hp electric motor on the injection pump.

Each of these motors stops and starts automatically as needed, without the necessity of an operator being on hand. The electrodes (Fig. 1) are so arranged that when the water level reaches a pre-selected level all water wells and water transfer pumps will stop.

FIG. 4. **Two electrodes,** lowest on the water leg, control the injection pump. If water falls to this level, all flow of water into injection wells stops. Wires shown here are normally enclosed in a raceway.



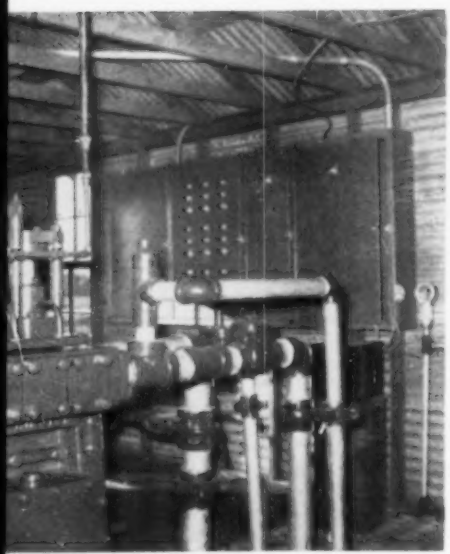


FIG. 5. **Control panel** is located in the injection station. Second panel from the left has control switches and indicating lights to show existing operating conditions.

As the injection pumps draw the water down past the third electrode water transfer pump No. 1 comes on automatically. As the water continues to drop, another electrode will start transfer pump No. 2, and thereafter transfer pump No. 3 will start. The three 3 hp transfer pumps cannot keep up with the 60 hp injection pump, so the next electrode to actuate a relay will start a 15 hp motor on water supply well No. 1. If more water is needed, the next electrode starts the 20 hp water supply well No. 2. Usually this is as far as the system goes; however, about four times each day additional water must be supplied. The next electrode stops water supply wells No. 1 and 2, and starts the 42 hp pump that rapidly catches up with needs of the system. (Supply wells No. 1 and 2 are shut down while the centrifugal pump operates, in order to prevent the kilowatt demand of the system from rising — raising the cost of electric power.)

Power Failure Precaution

In the event of a water supply failure, the system has an electrode 18 in. from the bottom of the tank which will shut down the injection pump. Each of the water transfer tanks is equipped with high and low-level electrodes to enable automatic operation of these tanks.

High Water Shut-Off

As an added safety feature, the system has a "high water shut-off" circuit that will shut down all the water sources if for some reason appropriate control circuits should fail to operate. Thus it is almost impossible for the central water tank to overflow.

If water is produced faster than needed, and as the level inside the tank rises, the various water sources are stopped in the reverse order from which they started.

How well does this system provide the advantages it was designed to produce? The operator found he was able to get along with two men less than before this system was installed. Also there has been **no** maintenance or repair work on this system since it first started operation.

Acknowledgment

The author expresses appreciation to T. B. Cochran & Wofford Cain for permission to publish this article; B. A. Barnes, production superintendent for Cochran & Cain, for his co-operation and assistance; and to the Lloyd Thomas Company of Wichita Falls, Texas, who designed and installed the system for assistance in assembling facts presented here. * * *

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Methods to increase existing oil production have progressed rapidly since Dinsmoor's accidental discovery of gas repressuring was made in 1888. As long as oil exists, however, oilmen will continue to search for a method of total recovery.

SECONDARY RECOVERY: Early and Late

Frederick Squires

Illinois State Geological Survey, Urbana, Illinois

INCREASING oil recovery has been, and will continue to be, an endless task of the petroleum engineer. Efforts aimed at increasing existing oil production dates back almost to the birth of the industry itself. Over the span of years, several methods of improving oil recovery have been attempted. Among the most successful are: (1) Perforating and hydraulic fracturing, (2) vacuum, (3) repressuring with gas, (4) repressuring combined with vacuum, (5) flooding, (6) flooding combined with repressuring (conjoint use), and (7) heat combined with repressuring. As long as oil exists, efforts will be made to improve these methods and extend the list of recovery devices.

A general history of secondary recovery and the methods employed follows, and is confined primarily to the events surrounding the writer's own experience through the years.

A discussion of perforating has been foregone, in favor of a more inclusive discussion of other methods. Shooting wells is an old and well-known method of increasing oil production, while pressure-parting has lately accomplished results along the same line. Pressure-parting was patented by the writer (Patent No. 2,561,639) for preparing coal veins for gasification. Therefore, this paper will focus more on pressure-parting rather than shooting wells with explosives.

Vacuum

After gas repressuring has proved its value in Pennsylvania, Ohio, and West Virginia, it should have spread into Oklahoma, but was delayed by vacuum, which had been used in Pennsylvania as early as 1869. Extracting gasoline from casinghead gas had proved commercially successful there and the larger the individual plants the more money each made. The result was that single large extraction plants contracted for all the casinghead gas over a great surrounding area. This precluded any repressuring because repressuring would hurt gasoline extraction. It was for this reason that the writer searched through and finally passed up Oklahoma and settled in Illinois for purchase of properties for repressuring, since Illinois casinghead gas was under no contracts.

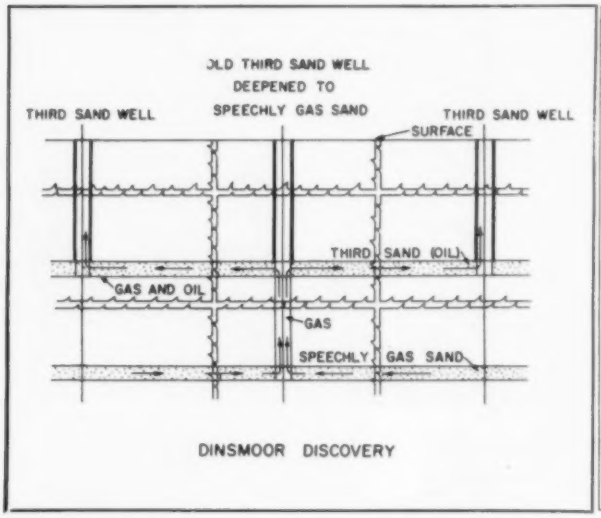

FIG. 1. **Accidental discovery** of gas repressuring was made by James D. Dinsmoor, when gas from the Speechly sand escaped upward into the oil producing Third Venango sand in an uncased well located in Venango County, Pennsylvania.

FIG. 2. **Gas repressuring** was extended highly successfully by Dinsmoor into the Cow Run sands in southeastern Ohio, following his Pennsylvania discovery. A patent suit in the 1920's, involving gas repressuring techniques, brought the Cow Run producing properties into the courts.

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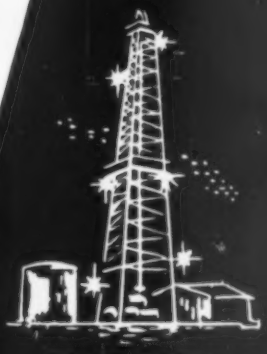

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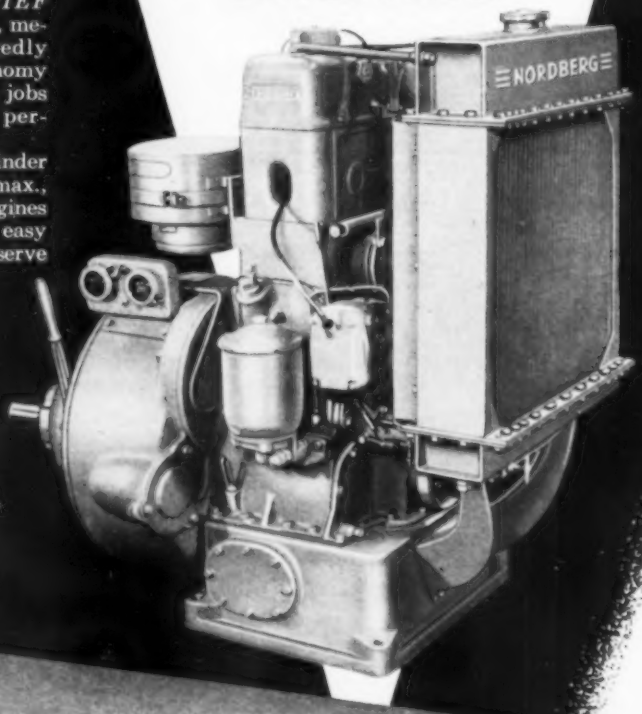

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Repressuring

James D. Dinsmoor observed the beneficial result of gas repressuring when, by accident, gas from the Speechly sand traversed and escaped through the upper oil producing Third Venango sand, in 1888, in an uncased well located in Venango County, Pennsylvania (Fig. 1). He applied this method to oil producing leases in Pennsylvania with Speechly gas and later extended its use by means of surface compression and vacuum. He expanded his operations into other Pennsylvanian areas and into the Cow Run sand producing area of West Virginia. The Petroleum Patents Company operated and licensed the use of the Mitchell patent in southeastern Ohio near the Dinsmoor leases just across the Ohio River in West Virginia (Fig. 2). This resulted finally in a bitterly fought patent suit, Petroleum Patents Company against, first the Carter Oil Company, and then Squires Brothers. The latter won the suit by proving Dinsmoor's previous use and previous patents. This was in the early 1920's.

It is interesting to note that the first applications of repressuring were made

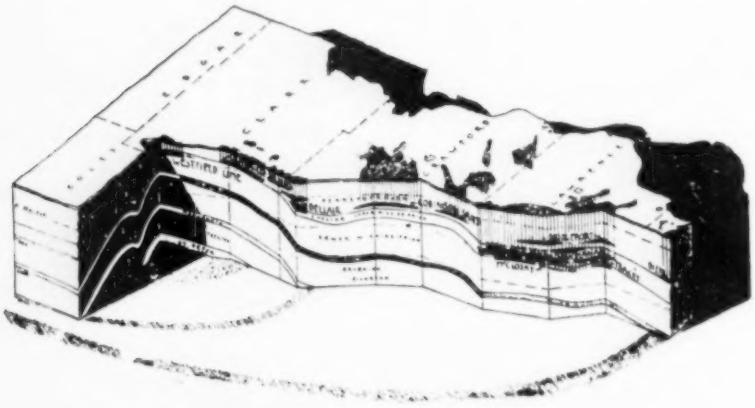
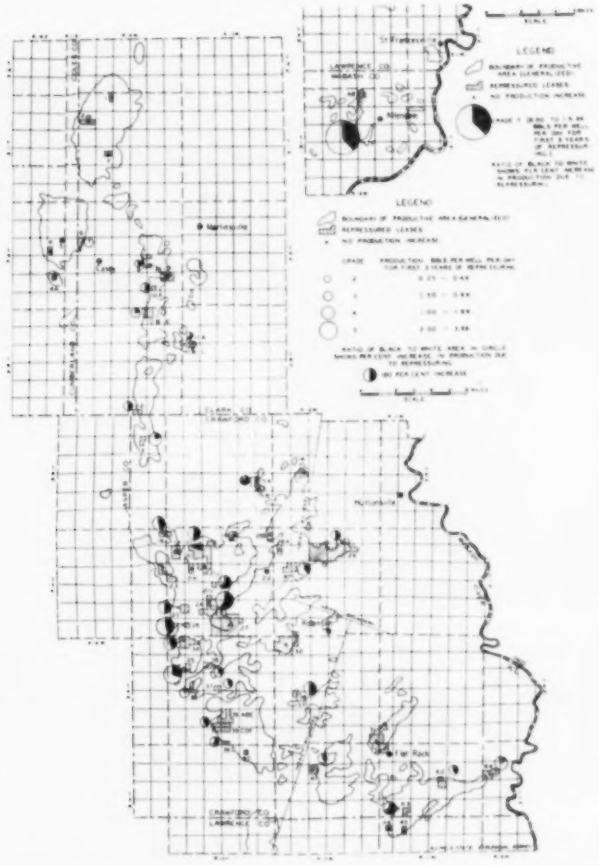


FIG. 3. **Block diagram** of southeastern Illinois oil field, where the Squires and Dinsmoor brothers inaugurated the first repressuring operation on the Mumford farm in Clark County, Illinois, in 1921 (after Bell).

FIG. 4. **Success of the gas repressuring** operations in southeastern Illinois field is indicated by the ratio of black to white areas in the circles. Date of map is 1930.

FIG. 5. **Repressuring** was first carried on along with gasoline extraction. Plants shown are in the Louden, Salem, and New Harmony fields, Illinois.



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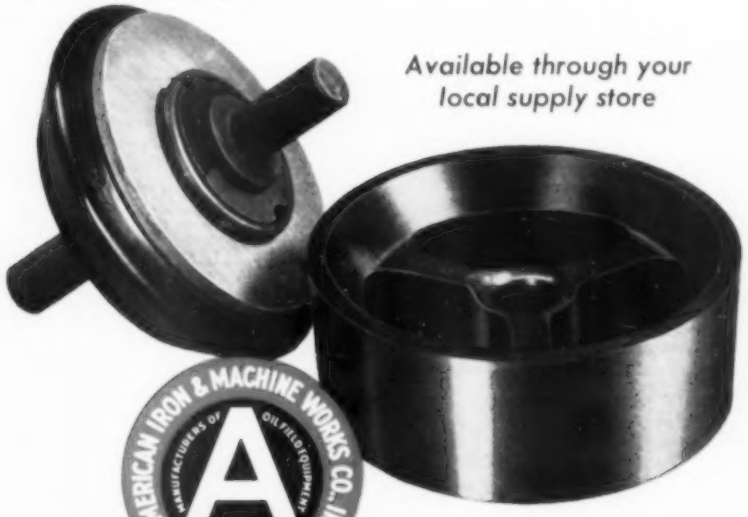

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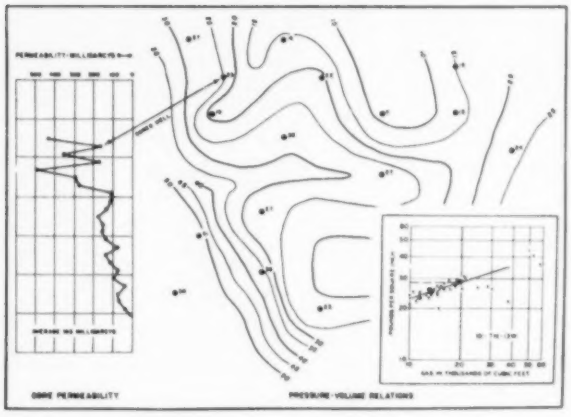

FIG. 6. **Permeabilities** established by gas repressuring the southeastern Illinois fields. Pressure-volume relations of the gas input wells and core permeability of the cored well proves valuable information for flooding operations.

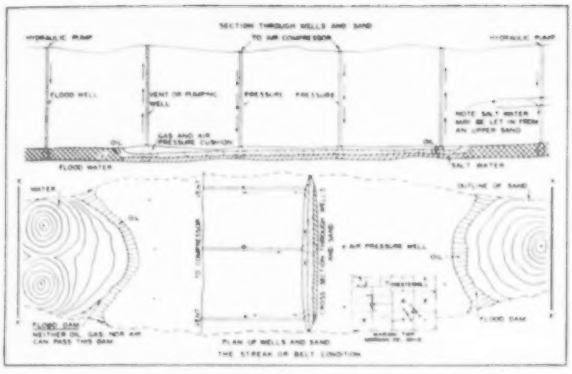

FIG. 7. **First flooding operation** in Ohio was a failure, believed due to low oil saturation. These section drawings illustrate both repressuring and water flood in this attempt in Morgan County, Ohio.

in areas in Pennsylvania, Ohio, and West Virginia, where conditions were favorable for immediate success and where this success led to an early expansion in the use of the process. Had it been tried first in almost any other area, no such degree of success or expansion would have resulted. The first application of flooding, also in a favorable location, was in the Bradford field in northwestern Pennsylvania. It is noteworthy that in early repressuring no input wells were drilled on lines between adjoining leases, a practice now required in most areas, and a process that could have been demanded by royalty owners had they realized a legal obligation on the part of the operator to do so.

At Malta, Ohio, Ranney drilled his first horizontal well at the outcrop of the producing Cow Run sand and into repressured territory (Fig. 2). It is surprising that this sand had produced oil wells within 100 ft from the outcrop. The gummy residue from the escaping oil and gas must have sealed off the sand.

The Squires and Dinsmoor brothers inaugurated the first repressuring operation on the Mumford farm in Clark County, Illinois, in 1921. This operation was in the southeastern Illinois oil field, which is shown in the block diagram of Fig. 3. It was successful, and many other operations followed it, as shown on map, Fig. 4, and the three photographs of large operations at Louden, Salem, and New Harmony, Illinois, where repressuring has been carried on along with gasoline extraction (Fig. 5). Permeabilities established by gas repressuring should be informative for later waterflooding (Fig. 6).

Dr. Edmund S. Merriam treated the gas from the Squires Brothers Chesterhill, Ohio, leases by his newly invented gasoline absorption process. This process later had a wide success in Louisiana and elsewhere following the enactment of a state law requiring the recovery of the gasoline content from all gas to be used later for carbon black manufacture.

Flooding

Believe it or not, the first patent on flooding was granted to a Russian. The waterflooding process first started at Bradford as a result of damaged well casing which admitted water to the sand. Observant producers then got the same results by purposefully admitting water into key wells and taking the oil resulting from the water push from the adjoining pumping wells. The first application of the process in Ohio was by Squires Brothers on the Howard farm south of Chesterhill, Fig. 2 and 7. The result was a failure, due, so it is believed, to low oil saturation. General knowledge of its failure retarded attempts at flooding in Ohio and West Virginia for many years. The first attempt in Illinois was a successful flood on the Kraft farm by Squires Brothers in 1924, and Fig. 8 shows the spread of waterflooding in Illinois by the end of 1954. Fig. 9 shows the method that resulted in McClosky dump flooding, which had been widely used in the Clay City Consolidated field of Illinois.

Conjoint Gas Injection and Waterflooding

A diagrammatic illustration of the conjoint injection of gas and water is shown in Fig. 10. This process has been used successfully in Texas and Louisiana. An area on which it could be applied to advantage in Illinois is the Johnsonville pool, as shown in Fig. 11 and 12.

Heat

The best ways to remove oil from oil sands are not by gas or water, but by solvents or heat. Solvents are too expensive on a field scale but removal by heat is probably practical. Fig. 13 is an early scheme for using heat. The heat process was recently demonstrated by an experimental operation conducted by Forest Oil Corporation and Worthington near Casey, Illinois. Fig. 14 and 15 show the area of the experiment and local permeability and sand richness, respectively. Fig. 16 is a photograph of the aboveground equipment. Fig. 17 and 18 are production graphs of results. The process removed all the oil, but at a cost greater than the value of the product. The present problem is to so design the equipment as to reduce the operating cost. For economic success, it must be automatic and be operated with cheap fuel such as lease gas. It is possible that the final equipment will consist of a water purifier, a boiler, and an air compressor, the steam from the boiler being injected by boiler pressure along with the air. This would reduce the excessive amount of nitrogen that was produced in the experimental setup and which diluted the produced gas.

This heat experiment was located on Forest leases in Section 30, Parker Township, Clark County, Illinois, adjoining a conventional waterflooding operation to the south (Fig. 14). The permeabilities and oil in place in the immediate vicinity are shown by contours in Fig. 15. The experimental area was a reversed five spot with an injection well in the center of a square formed by four producing wells. The sides of the square were 110 ft, making the distance from heat input to producing well about 78 ft. A second well was drilled 30 ft west of the center

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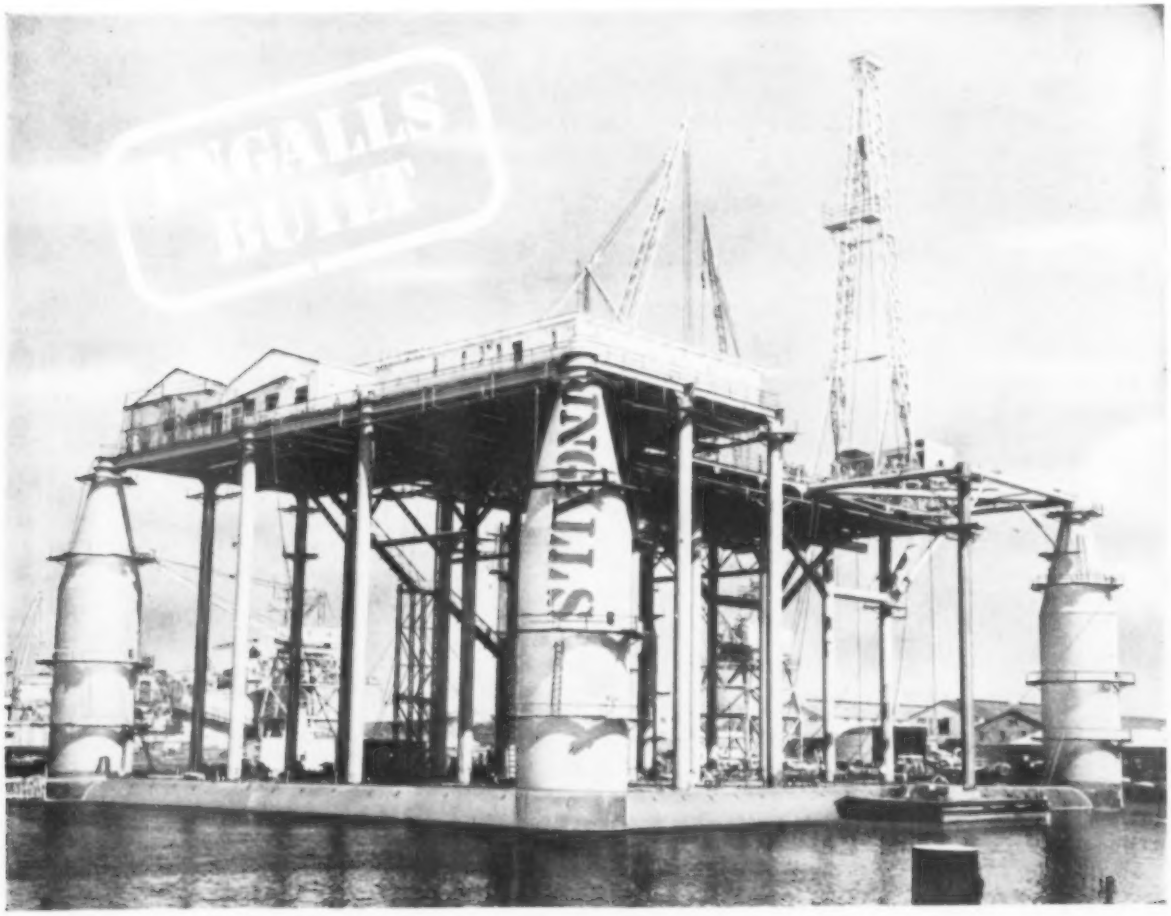

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well for early testing. The area included in the square is .278 area or in round numbers, a quarter acre.

Characteristics of the sand under the test site follows:

Sand thickness—35 ft.

Depth to sand—300+ ft.

Sand porosity—20 per cent.

Sand average weighted permeability —400-700 md.

Sand average water saturation — 27 per cent.

Sand average oil saturation—45 per cent.

Average oil content of general area surrounding test site—24,000 bbl per acre.

Crude viscosity at 100 F—178 S. U. API.

Crude viscosity at 100 F—178 5.0 seconds.

The center well was drilled first, then a well 30 ft west of it, and injection started. Following this the four corner wells were drilled. The corner wells were produced by flowing, as was the well west of the original hot well. After the experiment was stopped, two cored tests were completed within the heated area to check the oil removal after heating, which showed entire removal of oil.

The plant: Plant consisted of a gas engine, air compressor, gas compressor, water purifier, water pump, and combustion chamber, all as shown in Fig. 16. Air and gas were pumped into the combustion chamber, and there ignited, while water was pumped into a jacket around the combustion chamber, and there turned to steam. The

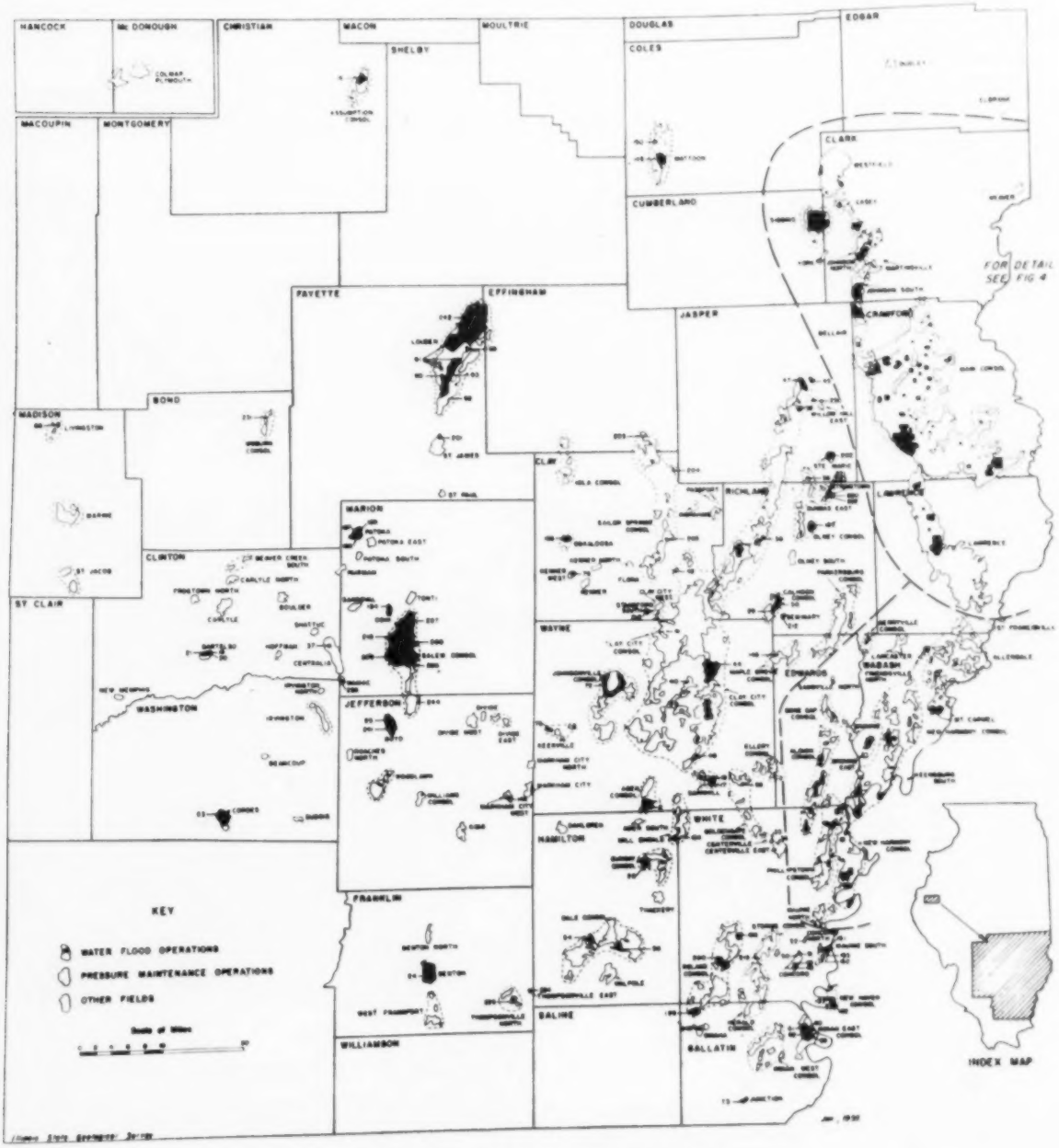

FIG. 8. **Early waterflooding** success in Illinois in 1924 led to quick acceptance, as shown by water flood success in 1954.

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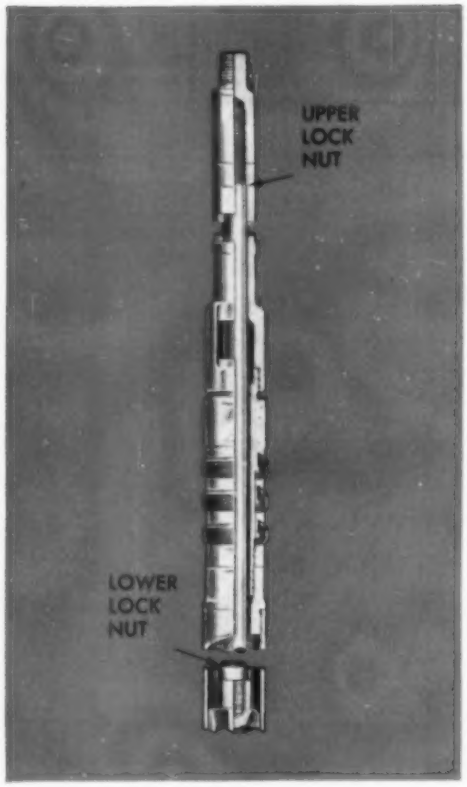

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resulting products of combustion and steam joined at the base of the combustion chamber, from which point they were piped to the injection well.

The air compressor had a capacity of 400,000 cu ft per day at pressures up to 500 psi. The temperatures at the combustion chamber could be varied from 350 to 900 F. This setup allows changes from pure air to combustion gases and steam. Oxygen can vary from 21 to 0 per cent. The power fuel was propane.

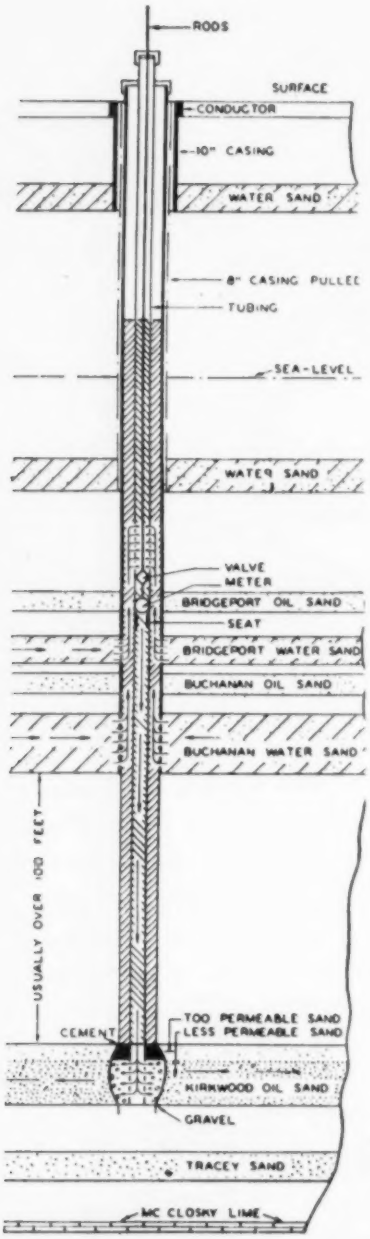


FIG. 9. **Dump flooding input well,** as widely used in the Clay City Consolidated field of Illinois.

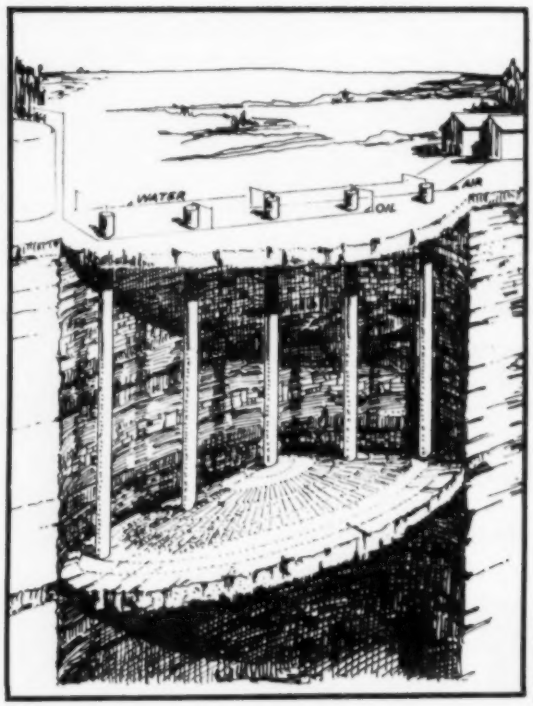


FIG. 10. **Conjoint injection of gas and water** is illustrated in this diagrammatic illustration. This process has been used successfully in Texas and Louisiana.

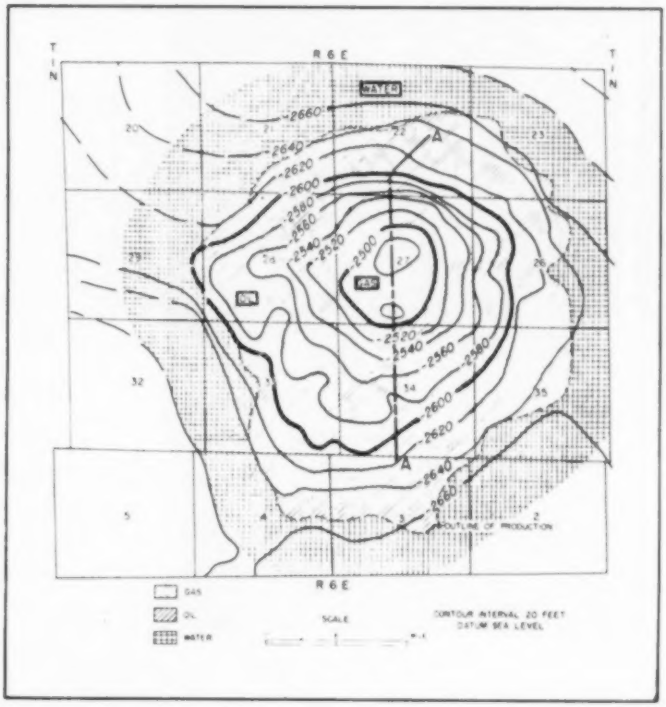
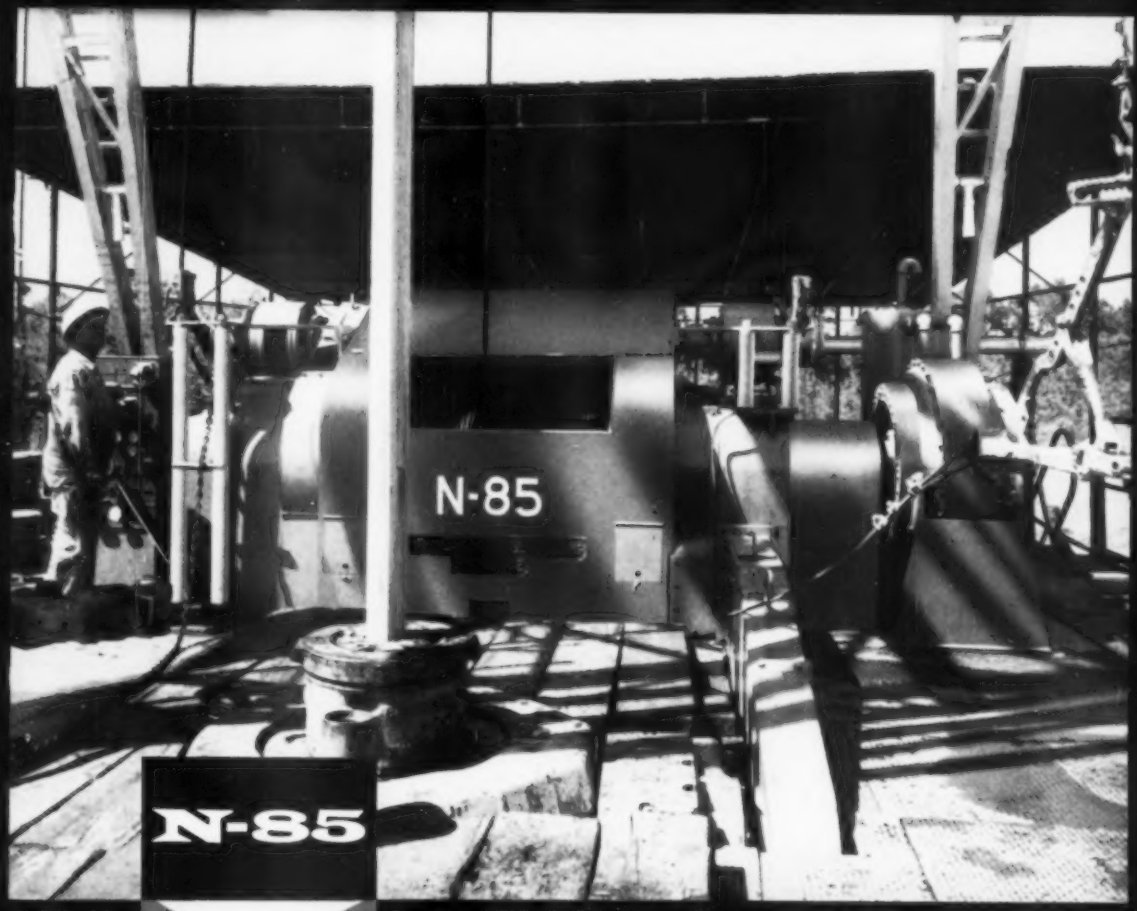


FIG. 11. **Conjoint injection field application** as is applicable to the Johnsonville pool, Illinois.

The test: Preliminary testing was made in September, 1953, between two wells 30 ft apart. Oil from the producing well started to flow in two weeks at one barrel per day which increased to eight barrels by December. Temperatures rose from 90F in September to 200F in December in this output well. The corner flowing wells reacted like the nearby west well, namely, first a rapid increase in temperature closely followed by a rapid increase in oil. Gas production later increased and oil production declined until the producing



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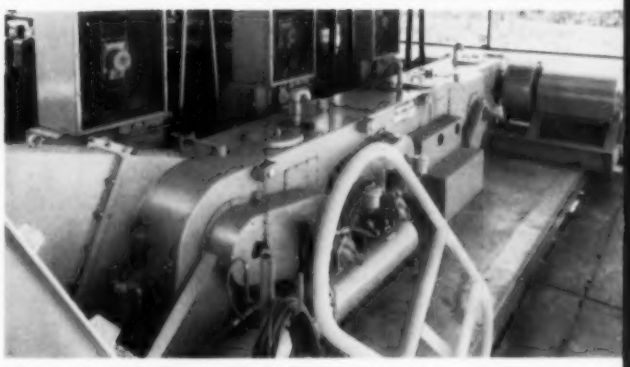

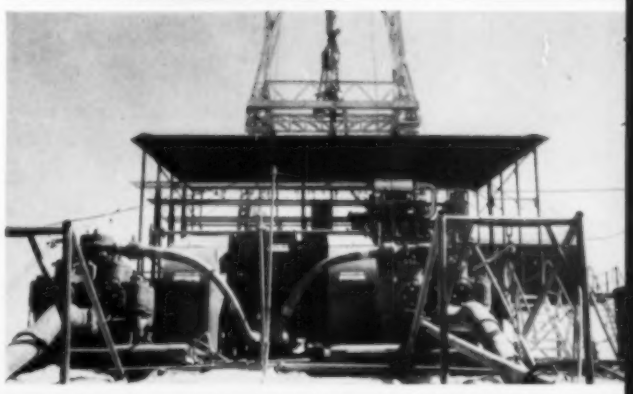

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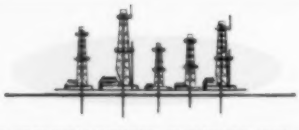
Brief Specifications Brewster N-85

Recommended Horsepower	850	Overall Height	7′ 2″
Drum Brakes (dia. x width)	46″ x 10″	Overall Width	7′ 11″
Drum Core (dia. x length)	24″ x 49¼″	Overall Length	21′ 0″
Drum speeds	8 fwd. & 2 rev.	Approx. Weight	37,000#—Less Catheads & Hydromatic
Transmission and Rotary Speeds	4 fwd.&1 rev.		



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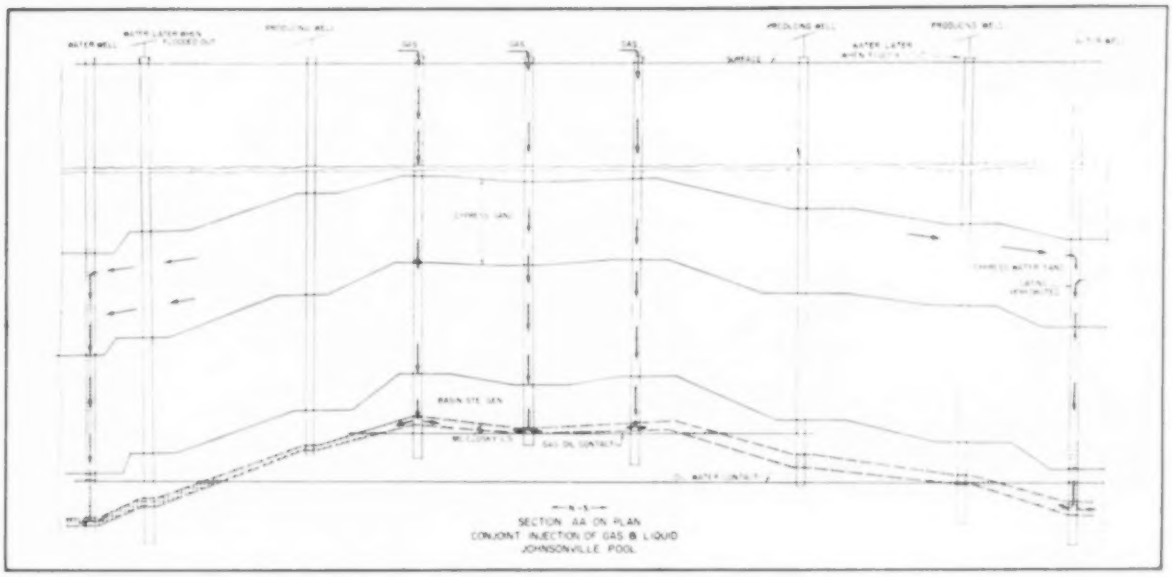

FIG. 12. **Cross section** of field application of conjoint injection of gas and liquid in the Johnsonville pool.

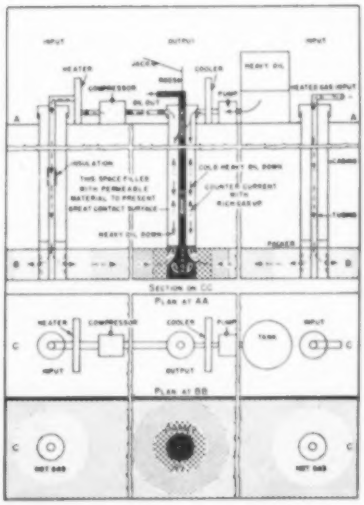

FIG. 13. **Heat** is sometimes considered to be one of the better ways to remove oil from the ground. This plan is one of the early attempts of applying heat to an oil reservoir.

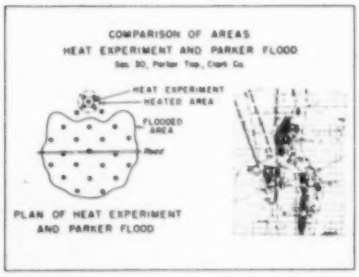

FIG. 14. **Comparison of areas** in the heat experiment of Forest Oil Corporation and Worthington near Casey, Illinois. Although the process removed virtually all the oil, cost was greater than the value of the produced product.

well made too little oil to pay for flowing. The corner wells were drilled in December, 1953, and January, 1954, and began to show temperature rises in October, 1954, and April, 1955. Differences in sand permeability reacted against a uniform progress of heat from input to producing well. The nearby water flood on the south did the same thing.

Production by two-month intervals is shown on Fig. 17. The production rate in unit volumes per day and cumulative production are shown on Fig. 18.

It is interesting to compare these results with the results of the waterflooding in comparable areas to the south of the heat experiment. The cumulative production on the 17 waterflooded acres has been 22,925 gross bbl, or 1300 bbl per acre over a period of about five years. In a small fraction of this time the heated ½-acre has produced 5300 bbl of oil, or at the rate of over 21,200 bbl per acre. This compares with the average per acre cumulative production of all Illinois repressured acreage of 500 bbl per acre and the average water flood production of all Illinois areas of 1000 bbl per acre. The time taken to get these gas repressure and water flood results has been many times longer than the length of the heat experiment.

Cost: Cost of the oil produced by the heat experiment has exceeded its value. A large part of the cost has been incurred because there was no effort to reduce it to a minimum, either in fuel cost or manpower cost, the effort being only to find out to what extent the process would remove the oil.

Final equipment: It is likely that the final equipment will consist of three elements only, a water purification system, a steam boiler, and an air compressor. One difficulty of the process as carried out has been the excess of nitrogen released in produced gas, which prevented its use as a fuel. The components of the injection stream are as follows over the experimental period:

Steam	40 per cent
Nitrogen	47 per cent
Carbon dioxide	6 per cent
Oxygen	7 per cent

There is considerable difference of opinion as to how the nitrogen was freed from the oxygen of the air. There

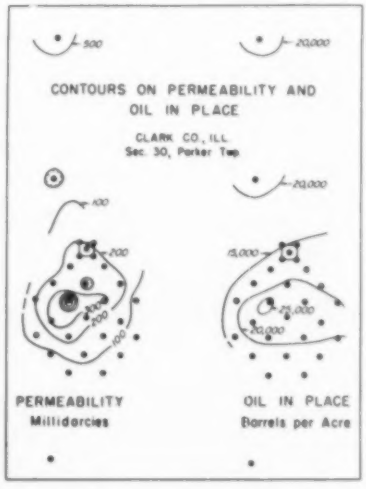

FIG. 15. **Contours on permeability** and oil in place in the adjoining heat experiment and Parker flood.

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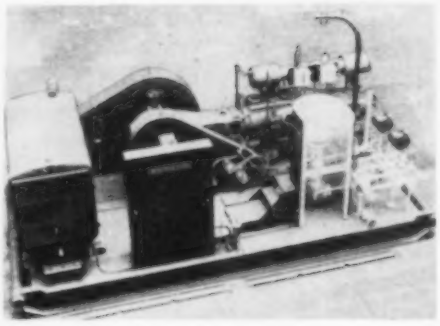


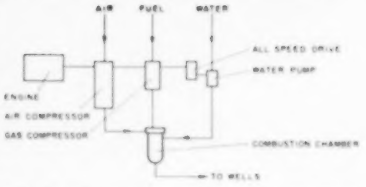


FIG. 16. **Aboveground equipment** for Clark County, Illinois, heat experiment. Plant consisted of a gas engine, air compressor, gas compressor, water purifier, water pump, and combustion chamber.

are those who hold that the oxygen was used to oxidize part of the crude, thus freeing the nitrogen. Others believe that the oxygen was taken up by the iron in the salt water, with the same result on the nitrogen.

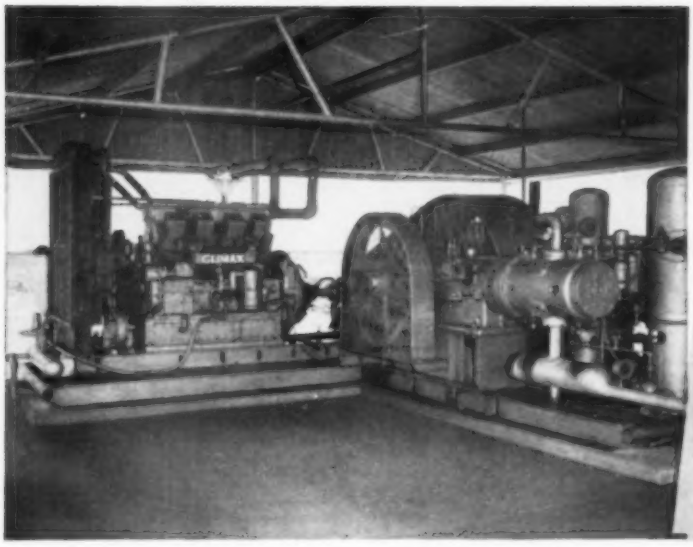
Fig. 19 shows the type of burner designed to be used at the bottom of a heat well.

Patents were obtained on heated gas (Patent No. 1,263,618) and heated water (Patent No. 1,249,232), each of which, while getting results on a small scale, did not prove to be successful on a commercial scale. Patent No. 2,584,605 is the final improvement that raises the heated water to a steam and injects the products of combustion with it.

Burning Coal in Situ

In order to maintain a fire in a burned coal vein, there must be a soure of air to support combustion, a fire, and a path for the exit of the products of complete or incomplete combustion. This problem of a passageway was solved by the process of lifting the overburden and clay removal through the passage thus formed (Patent No. 2,561,639).

The unusual sequence of strata immediately below coal beds is fire clay, calcareous clay, and limestone, in descending order. Of this series, the fire clay is the only part readily dispersable by water and it is also the weakest to resist horizontally applied force. The process of preparation of the coal vein for firing consists of removing all or part of this fire clay beneath the coal and is done by drilling and casing two



One of two Climax V-85 installations at Tex-Penn's Plymouth Field near Corpus Christi, Texas. Engines drive gas compressors on a closed jet system.

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Mr. F. F. Dueser, Production Superintendent, Tex-Penn Oil Co., Corpus Christi, Texas, states that he is "well satisfied" with his Climax engines. Both V-85 Units operate on a 24-hour per day, 365 day yearly basis and minimum downtime has been encountered since installation. "In addition, my Climax engines give excellent performance, operate at low cost per horsepower and are dependable," comments Mr. Dueser, "and I strongly recommend them for any similar oil field applications."

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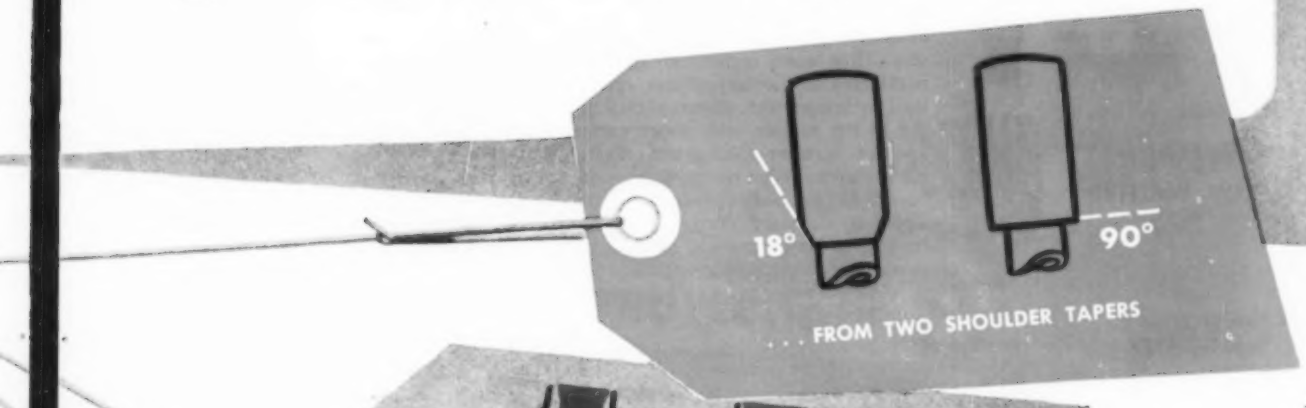

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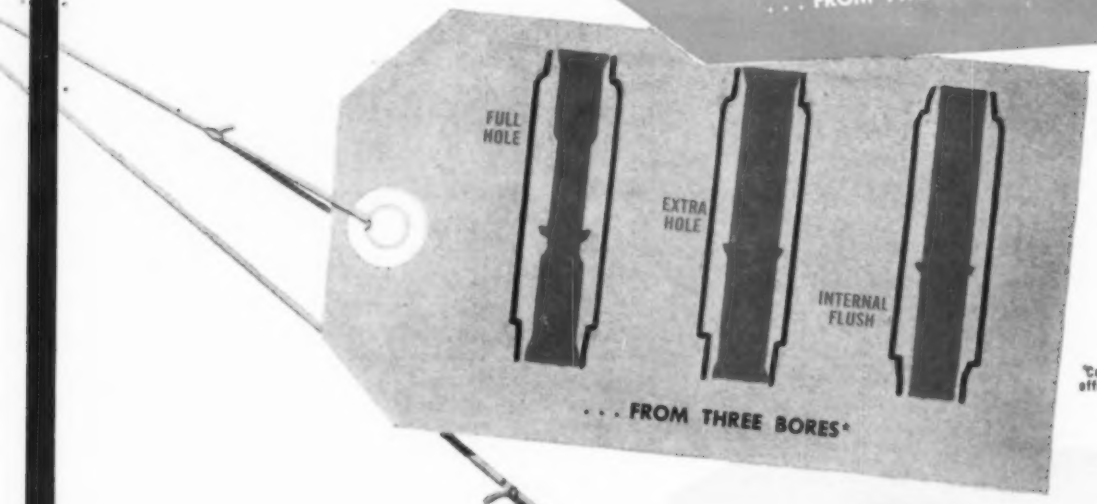

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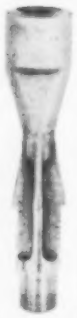

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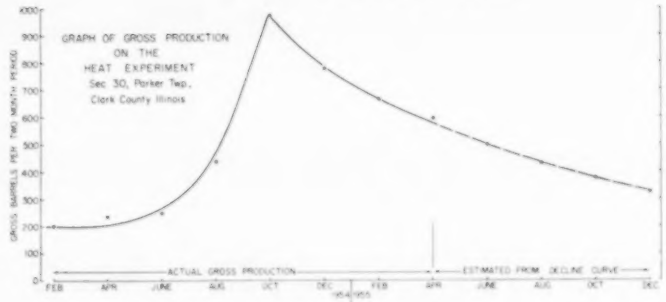
FIG. 17. **Gross production** on the heat experiment far exceeded results of the water flooded area. The heated area produced at a rate of 21,200 bbl per acre in a period of months, while the water-flooded acreage produced about 1300 bbl per acre in five years.



or more wells through the coal and into clay. Then water under high pressure is directed in a rotary stream against the clay in each well, dispersed clay rising to the surface with water in the annulus between tubing and casing. After clay has been removed from the bottom of the wells, pressure on the water is increased enough to cause fracturing between wells and permit passage of water between wells.

After the water pressure has opened this void, the water is removed by air pressure applied to the high part of the void, water being driven to the surface from the low part of the void. Fire is then started in the coal at one well, air is pumped into the same well to keep the coal burning, and the products of combustion, which will be producer gas, will pass under the coal to exit wells. This process may be alternated between input and output wells.

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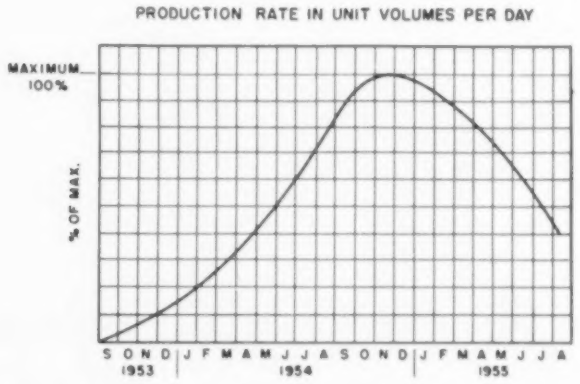
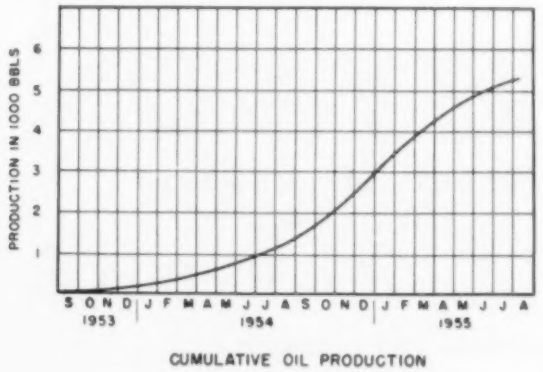


FIG. 18. **Production rate** in unit volumes per day and cumulative oil production in the Clark County, Illinois, heat experiment. The ½-acre under test produced 5300 bbl of oil in 24 months.



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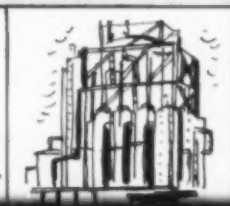

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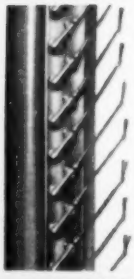

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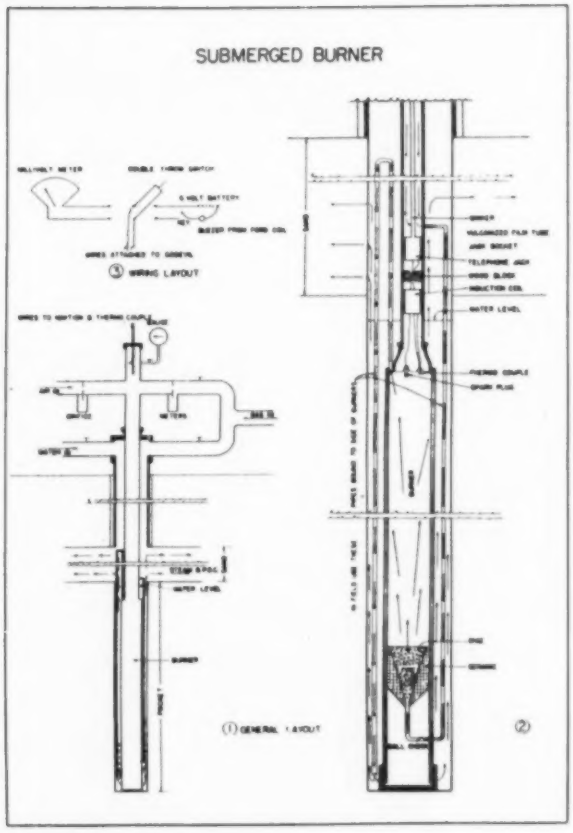

FIG. 19. **Submerged burner,** as designed to be used at the bottom of a heat well.

coal vein for burning has been described, comes the step of connecting this to the production of oil (Patent No. 2,584,605). Coal and oil occur in the same geographical area in many cases. When Squires Brothers were producing oil from the Cow Run sand at Buck Run in southeastern Ohio (Fig. 2), the diminishing gas supply from the oil wells was augmented by drilling gas wells to the Upper Freeport or No. 7 coal.

The fire is started in one well and maintained by air under pressure. The heated products of combustion escape into the overlying permeable oil sand, travel to the output well, and in their path gasify or partially gasify the oil.

Oil sands are found contacting lower coal bodies in the Lower Siggins pool and the second sand at Bellair in Illinois and in many other areas, especially Ohio, West Virginia, and Indiana.

To produce oil by heat from a permeable coal bed, fire is started in the permeable coal bed, maintained by air under pressure, which causes the hot products of combustion to traverse the permeable coal bed and escape via the second well into and through the oil-containing sand, from which it issues along with the evaporated oil through the annulus of the air input well. Air passed into and through burning coal will leave the coal in the form of producer gas, removing about two-thirds of the heating value in the coal.

The Gorgas, Alabama, Bureau of Mines experiment in underground gasification verified the picture just described. The burning mine was oblong in shape and there had been drilled at right angles to its long axis a number of equally spaced test wells to check the position of the burning face. These wells were cased only to a sandstone overlying the coal and were open hole below it, and terminated in the coal. After completion, they were capped. When the fire reached the nearest hole, the hot products of combustion entered the well and invaded the permeable sandstones above. A new well at a considerable distance from the burning face showed gas when the sandstone was penetrated.

Acknowledgment

The paper, prepared by Squires, was delivered at the Interstate Oil Compact Commission meeting, Dallas, Texas, before the Secondary Recovery and Pressure Maintenance Committee on May 31, 1956, and presented by Paul Witherspoon. ★ ★ ★

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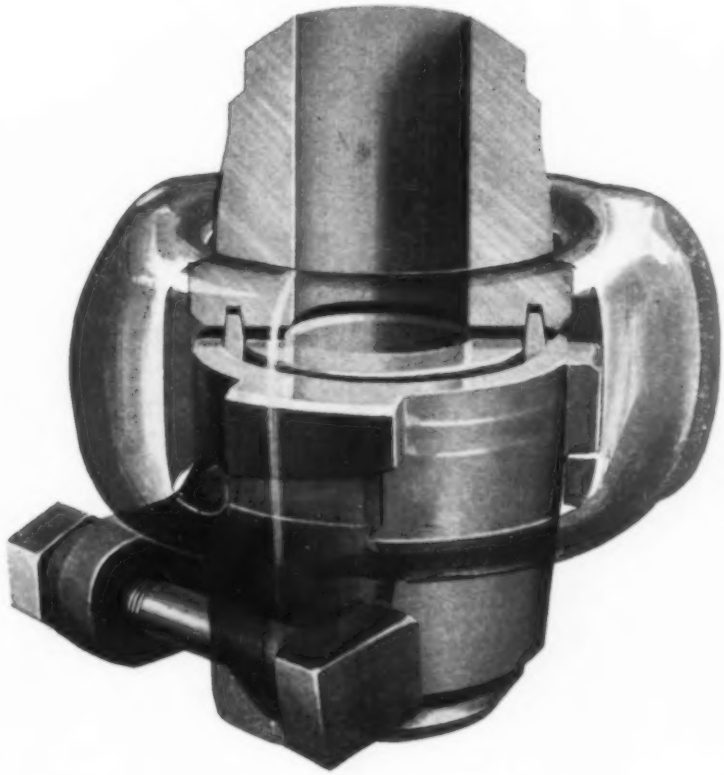

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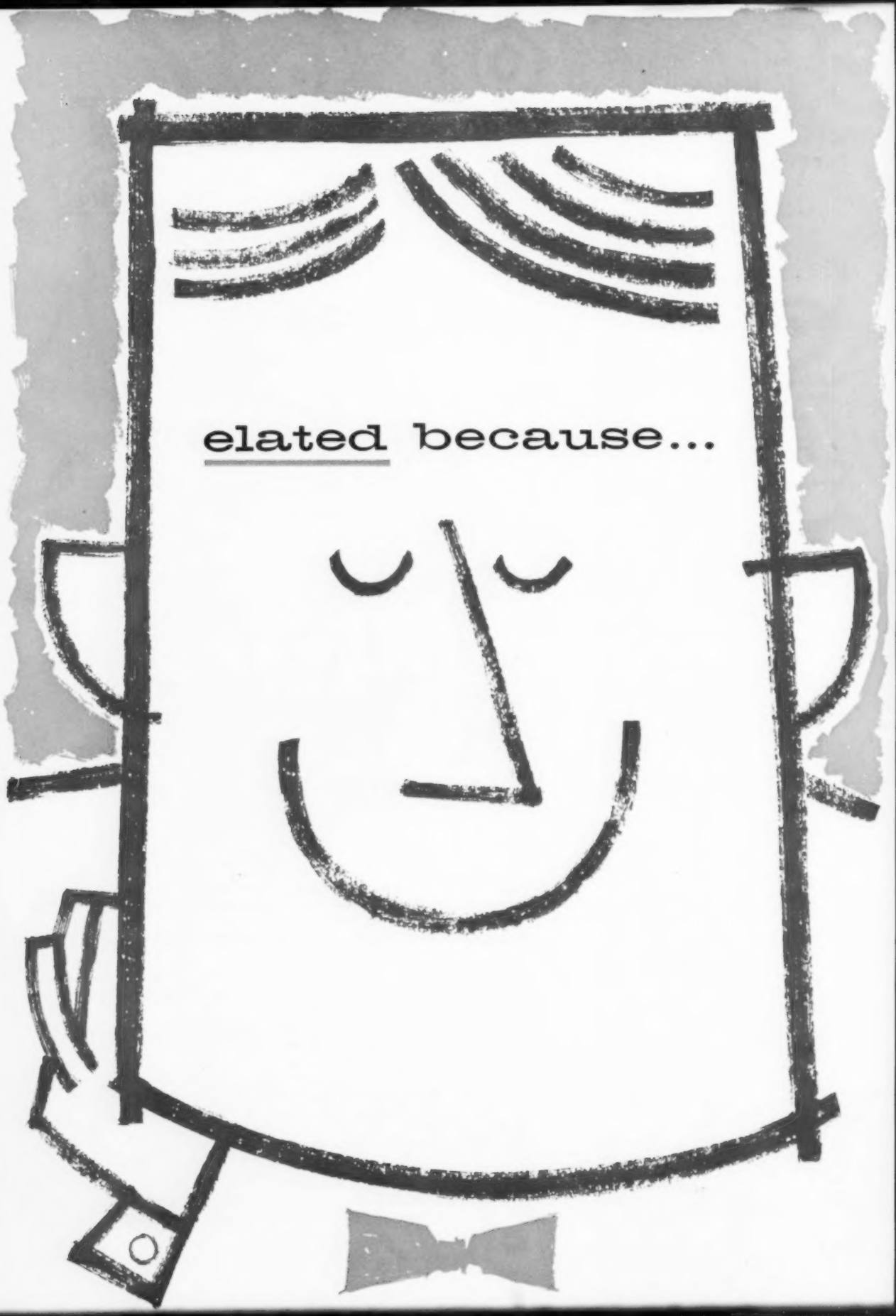
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Sun Oil Company tests in 350 Gulf Coast wells indicate several advantages of this company designed and engineered dump bailer:

- Down-hole mechanical method of inhibitor injection on bottom,
- Well shut-in periods are usually limited to one hour,
- Company field men are relieved of treatment duties,
- Cost of labor and liquid inhibitor slightly above cost of stick inhibitor alone

Victor W. Maxwell
Sun Oil Company
Beaumont, Texas

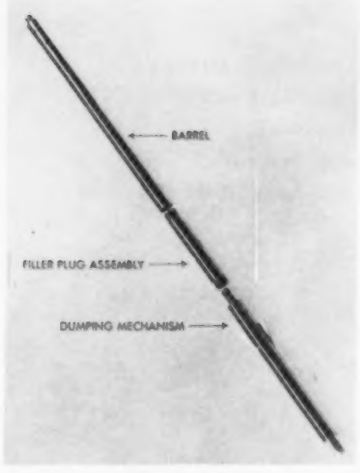

FIG. 1. **Dump bailer** has three major parts: (1) Barrel to contain the liquid inhibitor, (2) the filler plug assembly, and (3) the dumping mechanism.

TREATMENT of both gas-condensate and flowing oil wells with organic corrosion inhibitors has always been troublesome. Doubt prevailed as to whether or not the inhibitor, either stick or liquid type, was getting to the bottom of the tubing string.

Various well conditions encountered complicated the efficient use of lubricators or pumps as a means of injecting the inhibitor. High fluid levels in the tubing, plus lack of agitation to cause dissolution or dispersion of the inhibitor in the fluid, perhaps play a great part toward preventing the inhibitor from establishing a film over the entire internal surface of the tubing.

The fact that the inhibitor injected by pump or lubricator into the tubing at the wellhead was only offering protection to the upper section of the string, while the middle and lower sections continued to show an increase in corrosion, was substantiated by tubing caliper survey. Therefore, a "down-the-hole" mechanical means of depositing a volume of an inhibitor at the bottom of the well was very desirable. A wire-line, liquid-type dump bailer was designed to allow the operator to protect all or any portion of the tubing string as was necessary to alleviate corrosion.

Design of the Bailer

The bailer consists of three major parts: (1) A barrel to contain the liquid inhibitor, (2) filler plug assembly, and (3) dumping mechanism. These parts are shown in Fig. 1.

The overall length of the dump bailer is 11 ft. The barrel is 9 ft in length, with a 1¼-in. inside diameter. The volume of the barrel is 2.3 quarts. This volume may be increased by extending the barrel to any desired length that can be safely and efficiently handled. The volume increase per foot of extension is 0.26 quarts, calculated. Sun Oil Company has successfully used 3-ft and 5-ft extensions. Maximum diameter of the bailer is 1½-in. The same diameter bailer is used for both 2 and 2½-in. tubing.

The first bailer designed, built and used by Sun Oil, incorporated a plunger-type mechanism for dumping the chemical at the bottom of the well only. This plunger disengaged an O-ring seal upon striking the bottom of the perforated nipple or a bomb stop, thus allowing the liquid to flow out through the barrel. Later models, which are presently being used, were altered to include a dumping mechanism dependent on a collar trip to disengage the O-ring seal at the first collar it struck upon being withdrawn from the tubing. This type enables the operator to dump the inhibitor at any desired depth. After the barrel has emptied, the collar trip recedes into the body of the bailer so that it may be safely withdrawn from the well. Fig. 2 and 3 represent this later model of the dump bailer in the closed and open positions, respectively.

The bailer is lowered into the well by means of a wire line. A portable lubricator, sufficient in length to handle the bailer used and equipped with a wire line blowout preventer and stuffing box, is used for injecting and retrieving the bailer. The rig used to run the dump bailer is similar to one

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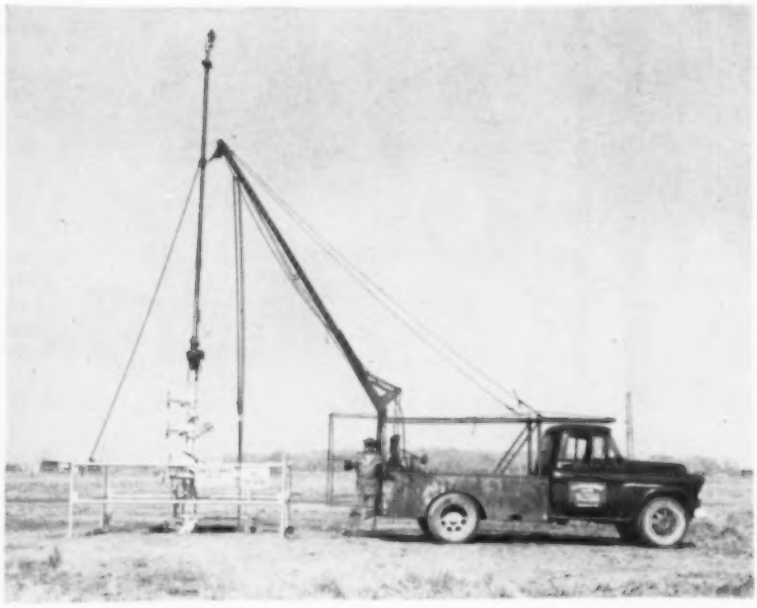
used for running a paraffin cutting tool. In most instances, the rig is used for both cutting paraffin and running the dump bailer.

Concentrated Inhibitors Used

Because the bailer is limited in volume, due to the overall length that can be safely handled without lodging the bailer in the tubing, it was considered desirable to use a concentrated inhibitor. Various inhibitor companies were quick to supply a concentrated form of inhibitors for use in the dump bailer.

Increased viscosity of the concentrated inhibitors posed a problem of handling. A hand pump had to be employed to pump the concentrated liquid into the barrel of the bailer. It was found that concentration above 80 percent for most liquid inhibitors were too viscous for the pump to handle effectively; therefore, concentration ranges were established from 50 to 80 percent, depending upon the viscosity of the inhibitor used.



Conventional wire line equipment for running liquid type dump bailer. Note the hydraulic lift rams used to raise and lower the mast.

FIG. 2. **Latest model** of Sun Oil Company's liquid dump bailer — closed. The unit is nine feet in length, with a maximum diameter of 1½ in.

FIG. 3. **Same size bailer** (closed) is used for both 2 and 2½-in. tubing. Bailer is lowered into the well by means of a wire line. Fins on the dumping mechanism allow dumping at the first collar struck when withdrawn from tubing.

Mechanism of Film Formation

A theory has been postulated to explain the mechanism of film formation. The theory proposes that the "slug" of inhibitor deposited by the bailer forms a film on the exposed metal surface as it moves upward after production is resumed. The area of exposed metal surface which the small volume of inhibitor will protect is dependent upon (1) the extent of adsorption of the inhibitor to the metal surface, (2) the thickness of adsorbed film, and (3) the concentration of the inhibitor used.

Adsorption characteristics of an inhibitor vary, depending on the molecular structure of the inhibiting compound. Also, the degree of solubility of the inhibitor in the well fluids influences adsorption to a metal surface or its desorption by freshly produced well fluids.

Actually, use of the liquid type dump bailer does not alter the mechanism of film formation from any other means of well treatment. It might be said to be analogous to the treatment of a well by use of inhibitor sticks, i.e., after the stick drops in the tubing to a point at which the temperature is sufficient to melt the stick, the melted "slug" moves upward after production is resumed, forming a protective film exactly as the "slug" deposited from a dump bailer.

Advantages and Disadvantages

Advantages. Perhaps the most important advantage gained by the use of the dump bailer has already been suggested; namely, that the mechanics of exposing the inhibitor to all of the internal surface of the tubing have been accomplished. The degree of protection offered by the inhibitor must therefore depend on such factors as treatment frequencies and treatment ratios.

In addition to the advantage mentioned above, there are two others worthy of recognition. (1) Shut-in periods, during or after treatment, are limited to about one hour for a run of 8000 to 9000 ft in depth. (2) Field personnel are relieved of treatment duties since contract labor is usually employed to run the dump bailer.

Disadvantages. The limit in volume of concentrated inhibitor per treatment imposed by the maximum volume of the barrel is the main disadvantage to the use of the dump bailer. In the treatment of a whole field on a regular schedule of two treatments a month, the treatment ratio (barrels per pound of active inhibitor) for each well varies according to the individual well production. The obvious remedy for such a problem would be to increase the treatment frequency (the number of treatments a month) on the wells with the higher production rates. The eco-

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nomics of treatment would be the only obstacle to prevent the operator from increasing the treatment frequency. Further work must be done to obtain answers to such questions as: (1) How often must a well be treated with a dump bailer to yield maximum protection? (2) What concentration of the inhibitor is best? (3) What is the duration of the adsorbed film? Such answers will ultimately yield an average treatment ratio and frequency which can be used in general for every well treated with the dump bailer.

Economics of Treatment

At present, the total number of wells being treated in the Gulf Coast division of Sun Oil Company by means of the liquid type dump bailer is 312 oil wells and 38 gas-condensate wells. These wells represent 21 different fields over the entire Gulf Coast division. Of the 468 wells under corrosion inhibitor treatment, 71.1 percent are treated by means of the dump bailer.

The cost for concentrated inhibitors ranges from 50 cents to $1.69 per quart. Contract labor cost for running the dump bailer is $6.50 per hour. In order to completely represent the cost of treatment by use of the dump bailer, tables are given below. These tables include an average cost of treatment per barrel of oil or million cubic feet of gas produced for each field. The frequency of treatment for each well was twice monthly. The average time for each treatment was 1½ hours.

For the whole Gulf Coast Division, the average cost per unit of production is given below:

Oil wells — 5.77 mills per bbl
Gas wells — 38 cents per MMcf

These averages are based on total costs and production for both Texas and Louisiana as cited in Tables 1 through 4. It is noted that the average cost per unit of production for the individual fields varies widely. This is because the treatment of each well was made with a constant volume of inhibitor and at a constant frequency of two treatments per month regardless of the individual well production. In other words, there has been no attempt to treat any well at a known concentration range using the dump bailer.

For the sake of comparison consider the cost of treating 4,394,308 bbl of oil (total production for Texas and Louisiana) given in Tables 1 through 4 at a concentration of 50 ppm. If the above production were treated with a stick type inhibitor, 34,913 sticks would be required. (For calculation, one stick is equivalent to one quart of standard 25 percent active inhibitor.) The total cost for inhibitor alone, at $1.25 per stick, would amount to $43,912.00, or an average cost of 9.9 mills per bbl. If a 75 percent concentrated liquid inhibitor were used with the dump bailer, 11,638 quarts would be required. The total cost for inhibitor alone, at $1.69 per quart, would amount to $19,668.00, or an average cost of 4.5 mills per bbl.

Labor Costs

Labor cost for dropping sticks is difficult to assess, because company labor is involved and the time necessary may vary from well to well. The labor cost for running the bailer in the preceding comparison would amount to $37,820.00. Therefore, the total cost of inhibitor and labor combined, using the dump bailer would be only $13,576.00 greater than the total cost of the stick type inhibitor alone.

Since treatment using either sticks or dump bailer would involve paraffin cutting in oil wells, no costs for this service are inculded in the tables or examples.

It is recognized that if the present treatment frequencies, using the dump bailer, have to be increased, the total cost may become more expensive than the cost incurred using older methods of treatment. The additional cost can be justified, however, because the operator can be assured that greater protection is offered to the entire string of tubing.

Acknowledgment

Original title of this paper was "A Preliminary Report on the Use of the Liquid Type Dump Bailer for the Treatment of Oil and Gas Wells." It was presented at the National Association of Corrosion Engineers T-1 meeting in San Antonio, Texas, October 23, 1956. ★ ★ ★

The Author

Victor W. Maxwell is in the production laboratory of Sun Oil Company, Gulf Coast division, in Beaumont, Texas. He is curren.ly engaged in work dealing primarily with the problems of oil and gas condensate well corrosion. Prior to joining Sun Oil Company in February, 1954, he was employed by Eli Lilly and Company, Indianapolis, Indiana, as a research chemist in the analytical department of the antibiotics division. He attended Baylor University, Waco, Texas, and received both BS and MS degrees in chemistry in 1950 and 1951 respectively. He is a member of NACE.

TABLE 1 — Texas Oil Wells.

Field	No. of Months	No. of Wells	Production Barrels	Total Inhibitor Cost	Total Labor Cost	Average Cost Mills/bbl
A	4	26	308,503	$ 808.38	$ 2,028.00	9.19
B	5	31	279,203	1,168.08	3,022.50	15.00
C	4	12	128,388	213.85	936.00	8.96
D	4	8	178,941	117.80	624.00	4.15
E	3	25	120,245	137.64	1,462.50	13.30
F	4	32	259,121	252.68	2,496.00	10.70
G	3	38	2,531,475	689.99	2,223.00	1.20
H	4	21	90,635	246.50	1,638.00	20.80
I	3	19	48,130	288.34	1,111.50	29.10
J	1	5	11,941	18.13	97.50	9.70
K	5	14	68,925	520.80	1,365.00	27.4
	TOTALS	231	4,022,507	$4,462.19	$17,004.00	

$$\text{Average cost per bbl} = \frac{\$4,462.19+\$17,004}{4,002,507} = 5.34 \text{ mills per bbl}$$

TABLE 2 — Louisiana Oil Wells.

L	3	4	16,393	$ 63.25	$ 234.0	18.1
M	3	22	189,761	253.10	1,287.00	8.12
N	3	27	165,647	452.92	1,579.50	12.3
	TOTALS	53	371,801	$ 769.27	$3,100.50	

$$\text{Average cost per bbl} = \frac{\$769.27+\$3,100.50}{371,801} = 10.4 \text{ mills per bbl}$$

TABLE 3 — Texas Gas Wells.

Field	No. of Months	No. of Wells	Production MMcf	Total Inhibitor Cost	Total Labor Cost	Average Cost Cents MMcf
O	4	3	2,253.8	$43.50	$234.00	12.3
P	5	9	166.2	65.25	877.50	56.7
	TOTALS	12	2,420.0	$108.75	$1,111.50	

$$\text{Average Cost per MMcf} = \frac{\$108.75+\$1,111.50}{2420} = 50.4 \text{ cents per MMcf}$$

TABLE 4 — Louisiana Gas Wells.

Q	3	2	664.0	$ 58.00	$ 117.00	26.4 cents
R	3	9	2,745.0	293.70	525.50	29.9 cents
	TOTALS	11	3,409.0	$ 351.70	$ 643.50	

$$\text{Average Cost per MMcf} = \frac{\$351.70+\$643.50}{3409} = 29.2 \text{ cents per MMcf}$$

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NATIONAL GRADE 62

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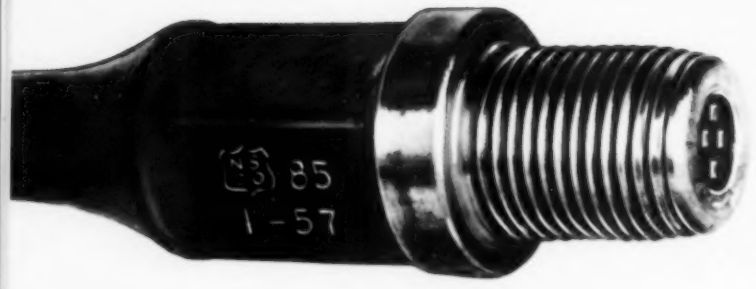
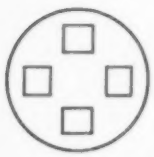
This is the newest in the National line and is specially manufactured to handle moderate to heavy pumping loads in areas where medium corrosion and medium sulphide conditions occur. Grade 62 rods are of top grade steel, normalized and tempered to give adequate resistance to shock, fatigue and impulse loads.

NATIONAL GRADE 81

Yield Strength — 65,000-75,000 PSI

Recommended for moderate to heavy pumping loads where corrosion is bad, but sulphides not severe. Ideal for wells where corrosive salt waters are prevalent. Made from type 4600 nickel molybdenum steels to give greater yield and tensile strengths, this grade will resist corrosion fatigue action under heavy service loads.





NATIONAL GRADE 85

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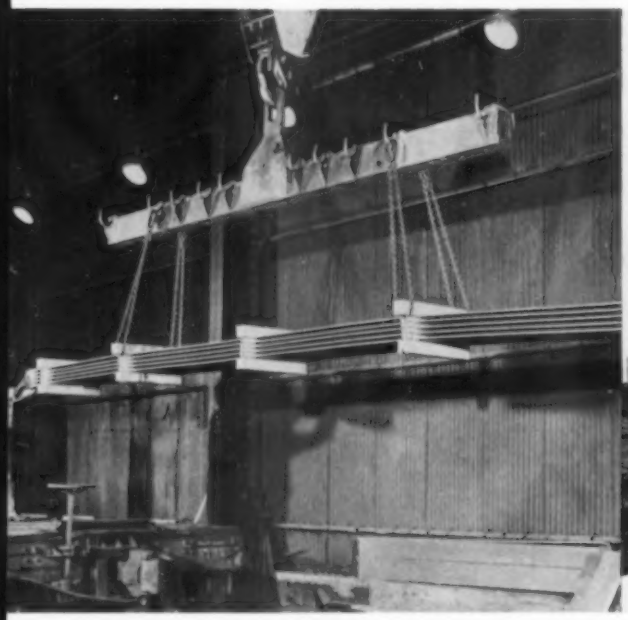

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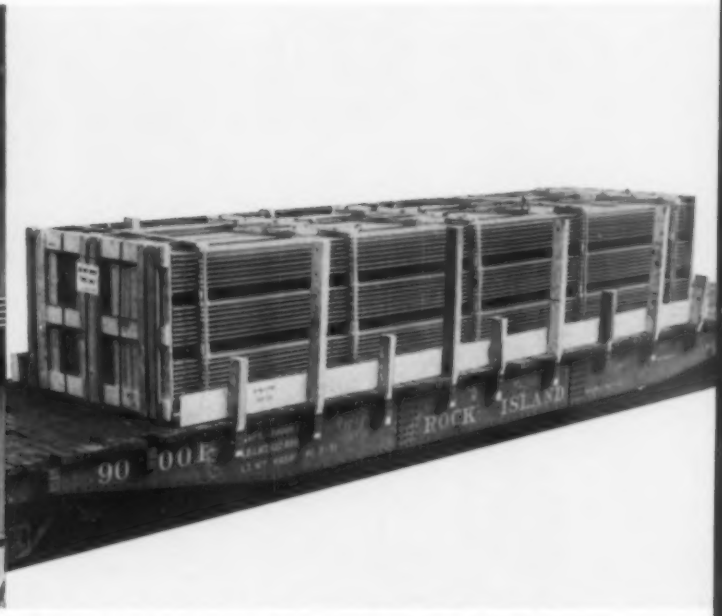

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More National production equipment on next page

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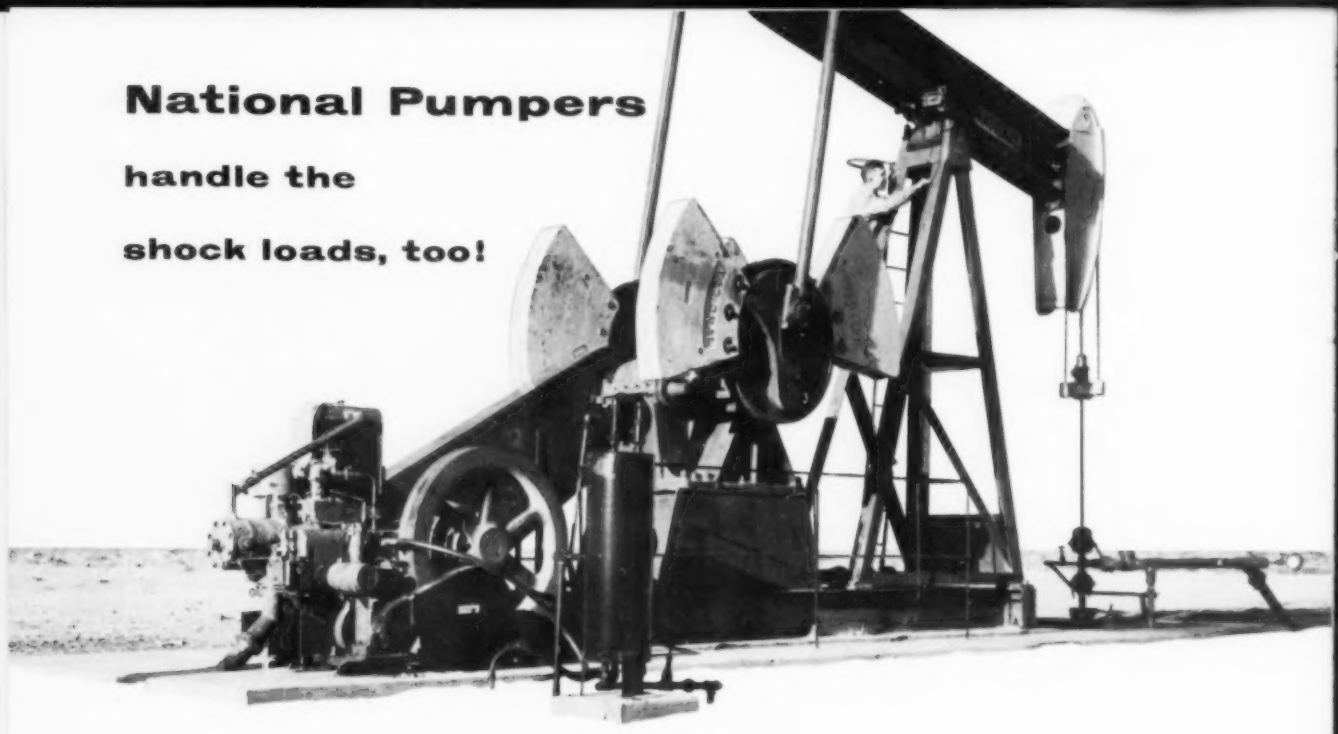

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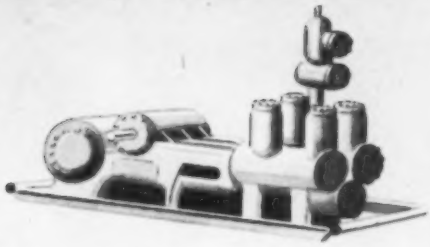

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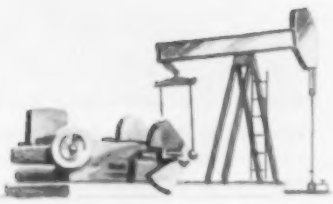

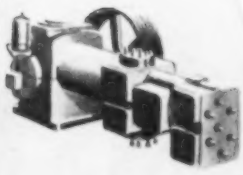

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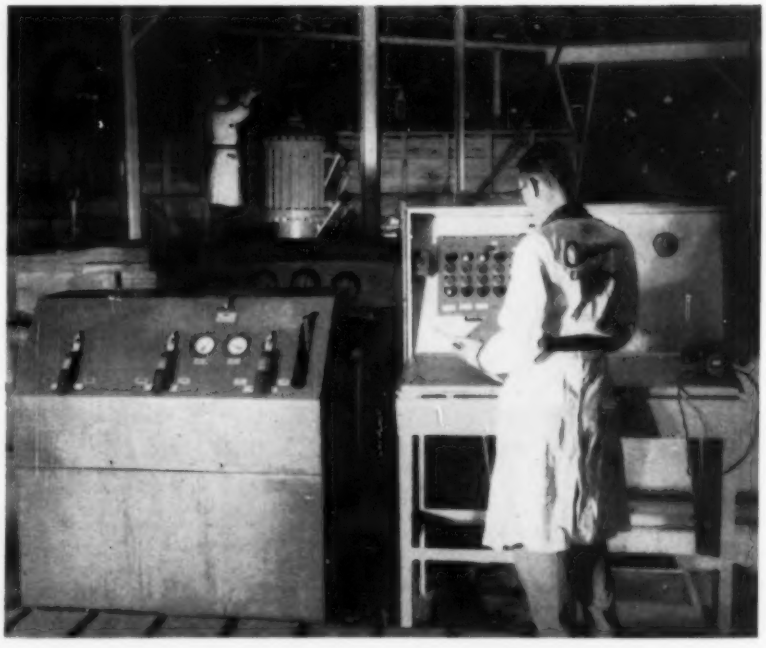
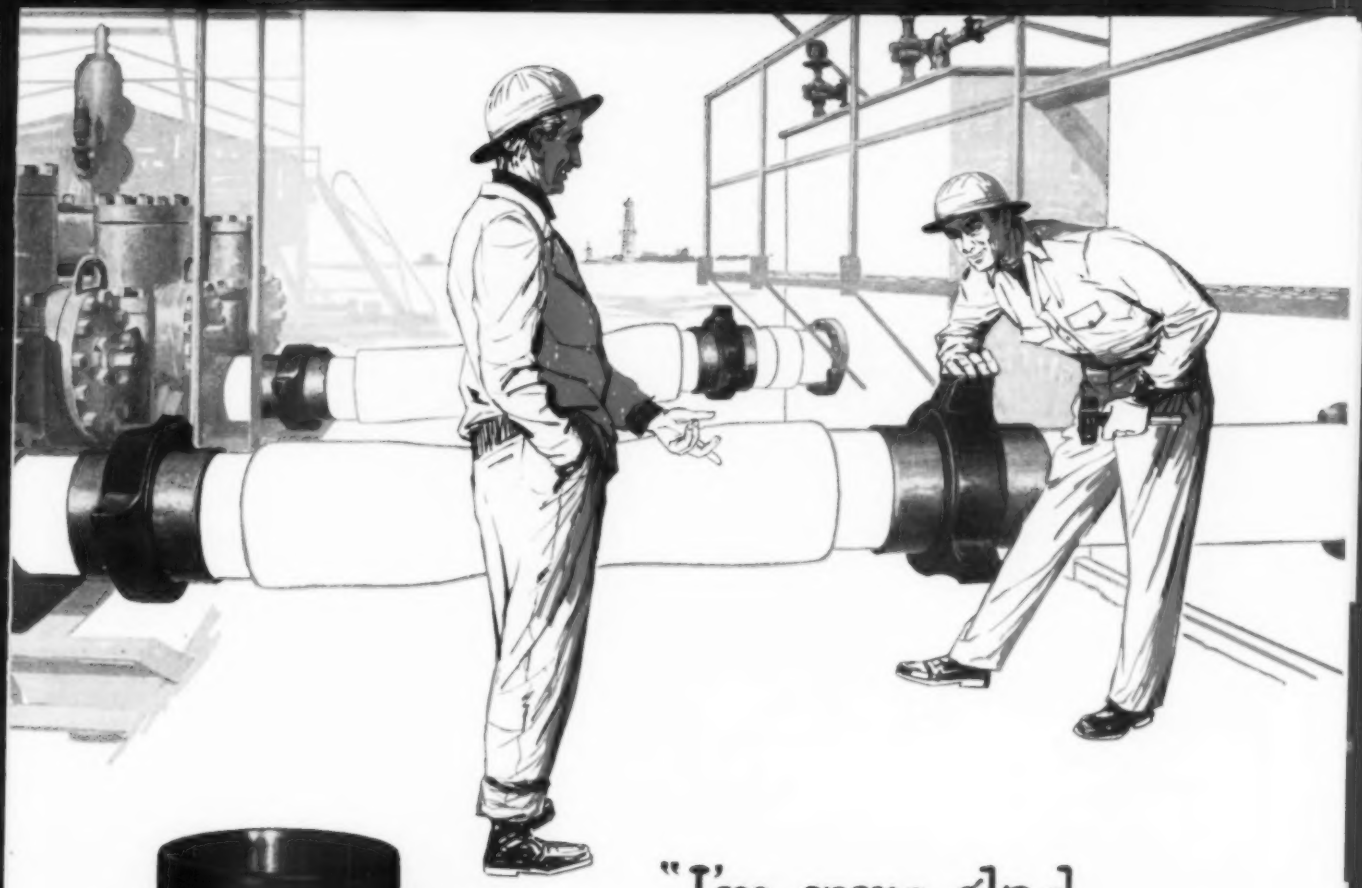


Main operating station of the test unit. The console at the left houses controls for the three master valves, while the board at the right contains switches, solenoid, delay service and opening and closing cycle timers.



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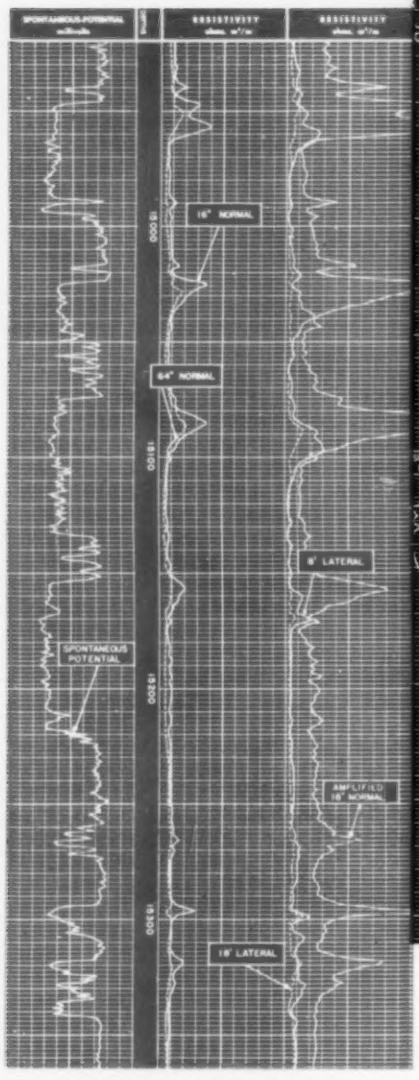

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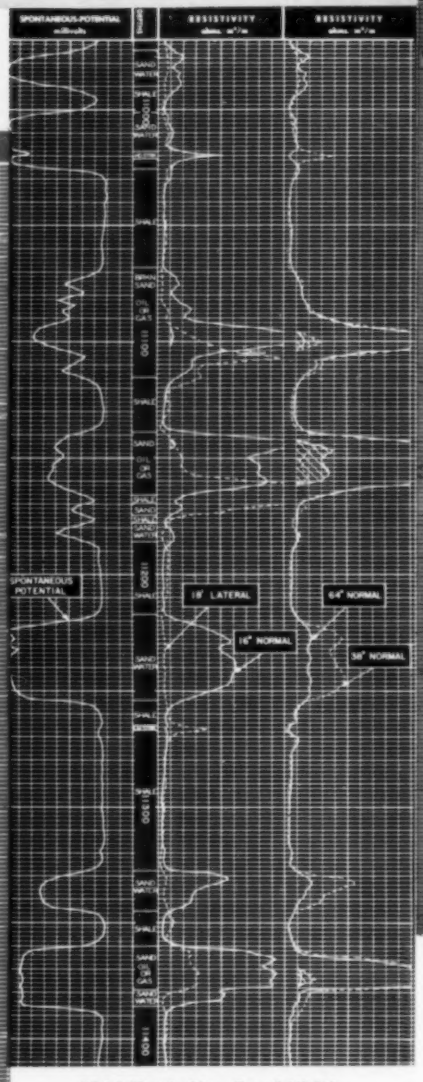

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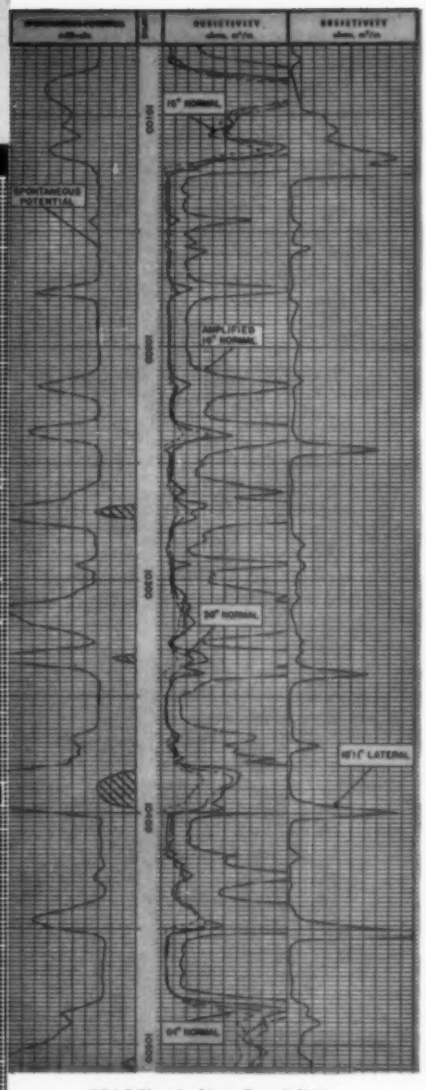

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The system consists of a hairpin loop of 12-in. pipe. Each side of the hairpin is approximately 40 ft long, and the loop of the hairpin is bent vertically to effect a gravity separation between the two sides of the stand. The end of each leg of the test stand is at the same level as the opposite leg, although the water side is approximately 1½ ft higher than the air side for most of the length. It is brought down to the lower position just behind the test valve. Purpose of the depressed end of the water leg is to prevent air override when flowing through the water side.

Main control valves are remotely operated oilfield drilling valves that were selected because of their relatively large bores and reliability under high pressures and shock conditions. Three main control valves are used, one at each end of the "hairpin" to select whether a water or an air test is to be made. The third valve is located at the loop to separate the two legs when desired to prevent water flow during an air test. All three control valves are operated remotely from the main control station with air-operated pumps and selector valves.

Pressure Supply

There are two sources of pressure to the test stand, one being water at 5400 psig and the other being compressed air at 2500 psig. These particular pressures were selected because they were already available for other purposes in the plant.

In the high-pressure water supply line, an adjustable choke regulates the rate of flow of high-pressure water in charging the system. This choke is controlled manually by a large hand wheel on an extension handle.

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In order to remove as much human element as possible from the testing, the entire sequence is controlled automatically after the firing button has been pushed. To accomplish this, the test valve is fitted with two spring-loaded microswitches that are actuated when the valve is fully closed or fully opened, respectively.

Cycle Results

Information derived from the valve testing with the new unit are:

1. Initial and final system pressures. This gives the pressure on the valve at the time it was opened and the pressure against which the valve closed.

2. Initial and final surge-tank pressure. This gives the pressure applied to the pneu-draulic operator at opening and at closing the valve.

3. Actual time required to open and to close the valve. This time is measured to the nearest .01 sec.

4. Consistency of operation can be determined from a series of runs while varying the surge tank pressure and noting the effect on the cycle time of the valve. Also, valuable information can be obtained by maintaining surge pressure constant in making a series of runs to determine if an appreciable variation in the cycle time is noted. For example, if the time cycle increases with each successive operation, it indicates that a failure is occurring within the test valve or operator. It can then be dismantled and inspected and the source of the trouble corrected. Inasmuch as very accurate time control can be kept, sources of eventual trouble can be located quickly and such sources eliminated before the valve is placed in service. ★ ★ ★

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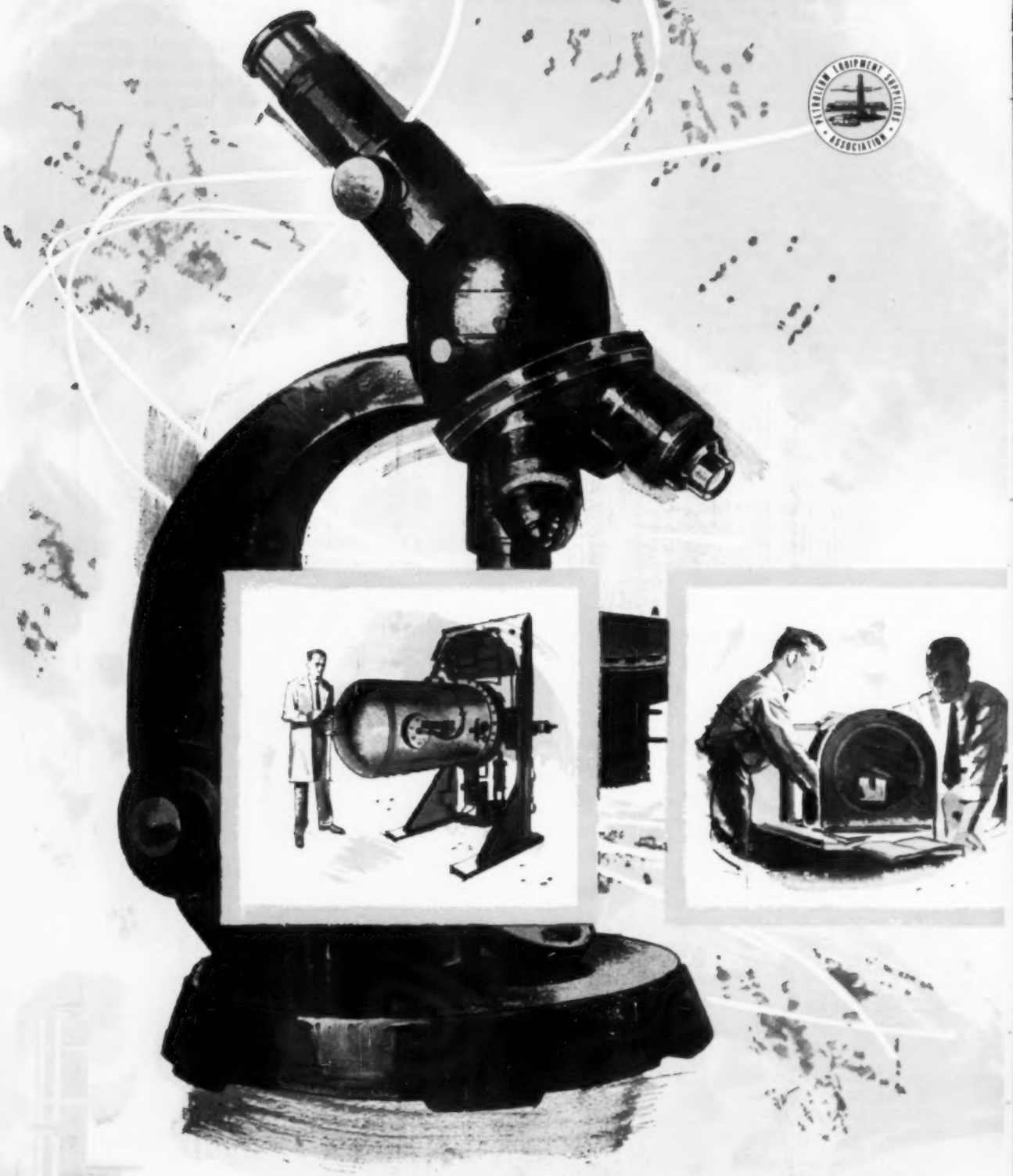

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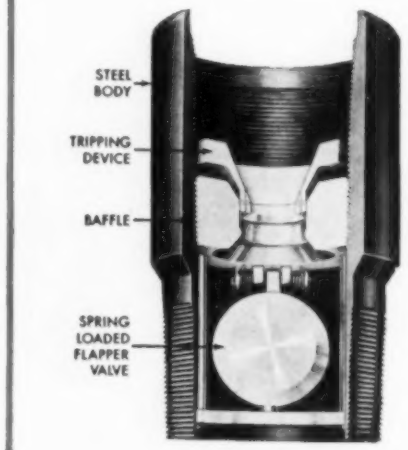
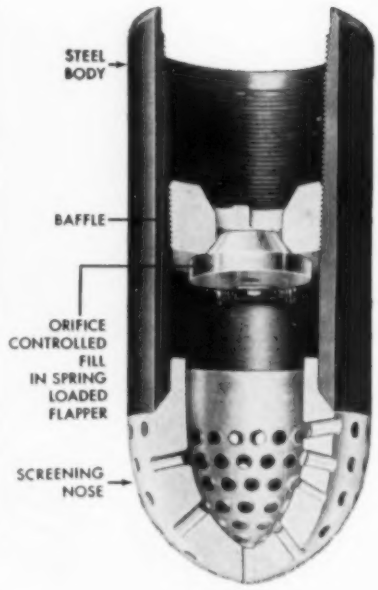
CONVERTS TO FLOAT WHEN DESIRED, by tripping flapper valve in collar which provides positive closure.





• Internal parts of both shoe and collar are a special aluminum alloy which has greater strength and abrasion resistance, plus easier and faster drill out.

The Type "O" Fill Shoe has a perforated aluminum alloy nose and baffle which is equipped with spring-loaded flapper valve with orifice choke. Orifice inserts are available in various choke diameters engineered for all pipe sizes.

The Type "O" Fill Collar has an aluminum alloy baffle, spring-loaded flapper valve and shear pin assembly for holding valve open. It functions as a back pressure valve or float collar. The flapper valve can be closed at any time by dropping a trip ball in casing at surface. At 650 p.s.i. pump pressure the ball releases flapper valve to provide a positive closure. Ball gravitates, or is pumped into nose of shoe.

If casing is run to total depth with orifice fill, ball is not used. Seating of cement plug on fill collar releases and closes flapper valve which then acts as back pressure valve, providing positive flow-back control.

OUR 25th YEAR

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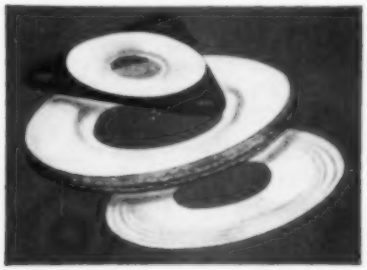
Better Things for Better Living . . . through Chemistry

PETROLEUM ENGINEERING NEWS

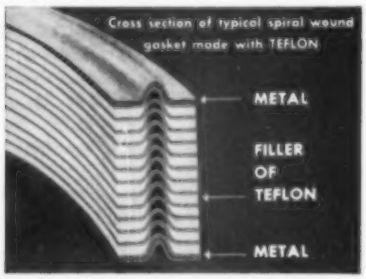
LATEST PROPERTY AND APPLICATION DATA ON **TEFLON®** tetrafluoroethylene resin

Gaskets and packings of TEFLON® resist corrosives and high temperatures...reduce downtime

PACKINGS of TEFLON provide uniform packing performance and long service life. Solid packings are impervious to liquids and gases. Low frictional coefficient of TEFLON reduces torque . . . increases mechanical efficiency. Impregnated asbestos packings and plastic packings are also available.



ENVELOPE GASKETS of TEFLON consist of a soft filler covered by a jacket of TEFLON. They are used for sealing large diameters and where bolting pressures must be limited, as in glass-lined equipment and pipe made from ceramics.



SPIRAL-WOUND gaskets and gaskets made from asbestos and glass cloth impregnated with TEFLON are used in high-pressure installations such as pipe joints, reaction kettles, steam couplings, pump bodies, pressure tanks.

Du Pont TEFLON is unaffected by petroleum distillation products, catalysts and reagents. For example, TEFLON is the only packing material used successfully in a 3,600-rpm pump handling highly corrosive butyl extract. This mixture of sulfuric acid and petroleum fractions is typical of the corrosive refinery fluids so easily handled by TEFLON.

All types of gaskets and packings are available in TEFLON. Most of the *mechanical* properties of solid TEFLON are comparable to those of the best grades of rubber-bonded compressed asbestos. Gasket design for the two materials is therefore similar. TEFLON has a naturally slippery surface. For this reason, less torque is needed to turn shafts or stems equipped with packings made of TEFLON, even under high gland pressures. TEFLON compounded with additives such as asbestos, bronze, calcium fluoride, glass fiber and graphite can be used where special mechanical properties are required.

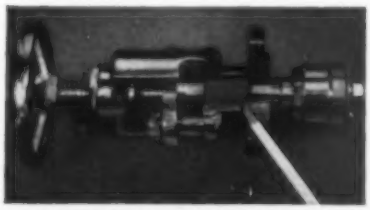
TEFLON tetrafluoroethylene resin is inert to nearly all chemicals and solvents in commercial use. The few exceptions to this include attack by the alkali metals under certain conditions. At high temperatures and pressures, halogens and certain halogenated chemicals and solvents may also affect TEFLON. The mechanical strength of TEFLON is high over a wide range of temperatures. This durable material is rated for use up to 500° F. and displays excellent properties at very low temperatures. Seals, bearings, packings and other components of TEFLON operate reliably year after year. Maintenance and replacement costs go down. Productive capacity is increased.

Wherever you have the problem of handling corrosive liquids or gases, especially at high temperatures, Du Pont TEFLON may well be the material you need for cost-saving operation. Find out what TEFLON can do for you by mailing the coupon below.

TEFLON®

is a registered trademark . . .

TEFLON is the registered trademark for Du Pont tetrafluoroethylene resin, and should not be used as an adjective to describe any other product or any component part; nor may this registered trademark be used in whole, or in part, as a trade name for any other product.



USED IN VALVE PACKING of petrochemical equipment, TEFLON offers outstanding resistance to heat and corrosives. Valves with packings of Du Pont TEFLON successfully handle nitric acid at 365° F. and dry chlorine gas at 100 lb./sq. in.

SEND FOR INFORMATION

Mail this coupon for additional property and application data on Du Pont TEFLON tetrafluoroethylene resin.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 352, Du Pont Building, Wilmington 98, Delaware

Please send me more information on Du Pont TEFLON tetrafluoroethylene resin. I am interested in evaluating this material for_____

Name_____

Company_____ Position_____

Street_____

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Type of Business_____

IN CANADA: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec

Tips on Mud Valves for Toolpushers . .

Zack Taylor (right) and Toolpusher Jim Wilkson discuss the MUDWONDER on the standpipe of the Falcon-Seaboard Rig No. 9.

Mud Valve Economy, Easy Operation Found In Rockwell-Built MUDWONDER

by Zack Taylor, Division Manager
Falcon-Seaboard Drilling Company, Denver, Colorado

ECONOMY . . . Easy operation . . . Have you searched in vain for mud valves that would give you these benefits? We did until our experience with Rockwell-Built *Mudwonders*. Now, we use them on standpipes, mudlines, mud tanks, blowout preventers, etc. Eight months of testing and using *Mudwonders* proved to us that they are superior to any mud valve we have ever used, regardless of application.

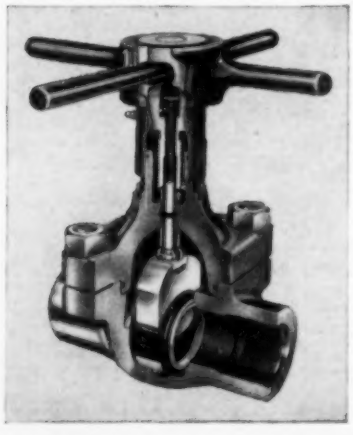
Economy means more to us than just long wearing parts which are inexpensive to replace. It means freedom from downtime and costly maintenance, too. *Mudwonder* valves give us "our type" of economy. We can inspect the inside of a *Mudwonder*, change the seat insert if necessary, and be ready for operation again while the crew makes a connection.

We never need a cheater or hammer on a *Mudwonder* valve. Easy operation is no longer a roughneck's dream. It's real . . . and at extreme differential pressures, too.

We can recommend *Mudwonder* to any toolpusher having mud valve trouble. *Mudwonder* valves are built in 2", 3", and 4" sizes with screwed or flanged ends for 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test).

See your favorite oil field supply store for complete information, or write Edward Valves, Inc., East Chicago, Indiana.

MUDWONDER cut-away view shows the double thread construction, separated stainless stem and hard chromed gate with "T" slot connection and the one-piece seat insert with the buna-N molded integrally over the steel wear rings.



ADVERTISEMENT

Round-Robin Program Airs AAODC Objectives

Most business men are members of at least one trade association or professional society. Most drilling contractors are members of several—AAODC, API, AIME, and local organizations. Each group makes certain demands on his time, and each has something special to offer, or else he would not be a member.

This is the basic thinking behind a new "chapter road-show," premiered at the December meeting of the Central Oklahoma Chapter in Oklahoma City, that presents the story of AAODC benefits to individuals and contributions to the drilling industry.

In Oklahoma City, four speakers — the Association's president, executive vice president, insurance consultant and public relations counselor — each explained a portion of the AAODC's program and policies.

Schedules are now being outlined for presentation of similar programs before other regional chapter meetings during the year. The plan is to invite non-member contractors and operators as guests, in order to present the story to the widest possible audience.

The program theme is that industry teamwork, by means of participating in Association activities, results in three-way profits.

First of all, there are tangible benefits to individual companies, such as practical assistance in technical, accounting or other problems. Second, there are accrued benefits which improve the status of the industry at large, such as insurance savings, better safety records and personnel training. The third, and still broader aspect, are the benefits to the industry as a whole — contractors, operators and suppliers — that mean better, safer, more economical drilling.

The AAODC holds an unusual position among trade associations in being able to demonstrate that work supported by membership dues returns a profit to the members. One profit, in the form of money saved, was reviewed by Joseph M. Shelton, who pointed out that better safety records and work with state regulatory bodies have resulted in sizable insurance premium savings. In Oklahoma, for example, contractors save $227,000 annually as a result of reduction in workmen's compensation rates.

Brad Mills reviewed other benefits made possible only by joint effort. Included are personnel training activities, such as short courses carried to the men in the field. Similar aids to upgrading personnel are the AAODC manuals and primers, financed in large part by members' dues.

Dowell operators "huddle" for a safety meeting before starting a well treatment.

ACID PETROFRAC

powerful one-two punch for "reluctant" formations

ACID PETROFRAC® combines the benefits of acidizing and fracturing. In some formations it has given better results than either fracturing or acidizing.

Since Acid Petrofrac uses an acid-oil emulsion as a fracturing fluid, many of the addition agents developed for regular acid may be used. For example, agents for intensifying, silicate control, or emulsion control may be used to tailor the treatment to the requirements of your well. Retarded acid action is inherent in Acid Petrofrac.

The emulsion reverts to a water-thin fluid after the treatment and returns easily to the well bore.

Discuss Acid Petrofrac with your Dowell engineer. It may be just the treatment your well needs to make it produce as it should. If it is not, you can depend on your Dowell engineer to recommend a service to give you the best results.

For service or more information, contact any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service; or write to Dowell Incorporated, Tulsa 1, Oklahoma.

Services for the oil industry

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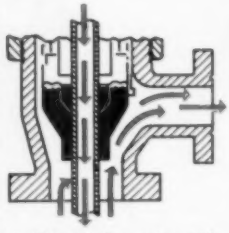
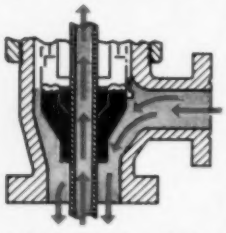
DRILLING WITH AIR OR GAS?



There is a steadily growing use of air or natural gas to replace the mud column in many drilling operations. Advantages include faster drilling rates, more footage per bit, no "lost circulation" problems, and greater production recovery.

The ideal unit for sealing off around the drill string and maintaining safe pressure control is the Shaffer Combination Rotating Blowout Preventer and Stripper. It not only permits the well to be drilled safely, but also it can be adapted to be used as a casing stripper during casing operations to maintain pressure control.

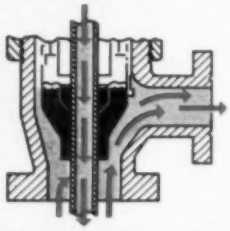
DRILLING WITH REVERSE CIRCULATION?



Reverse circulation is another of the modern drilling techniques that have definite advantages in certain types of formations. By returning the cuttings through the inside of the drill string, higher return velocities are obtained at lower pump pressures (and lower pressures on the formations). The higher velocities insure larger cuttings being returned from the formations, in many cases eliminating need for coring and thus saving rig time. Also by carrying large cuttings away faster, bit life is lengthened and drilling time is reduced.

These and other advantages make Reverse Circulation techniques worth investigating — and here again, the key to proper operation is a Shaffer Combination Rotating Blowout Preventer and Stripper to seal off the drill string and to control circulation pressure while drilling.

NORMAL DRILLING OPERATIONS?



Here again, this Preventer and Stripper insures safety and efficiency to a degree unmatched by any other type of hook-up. The unit seals off around the varying diameters of the drill string — pipe, couplings, tool joints and drill collars — adjusting itself **automatically** to the various diameters and shapes. It even seals safely around such shapes as square, hexagon or octagon kellys. And the seal is automatically maintained as long as the drill string is in the hole. No valves to operate, no levers to move — nothing to remember or forget when pressure emergencies threaten.

GET ALL THE FACTS

on the uses and design features of this unit by sending for the helpful 36 page brochure. It's free to qualified field personnel, engineers and executives!

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FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 546
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
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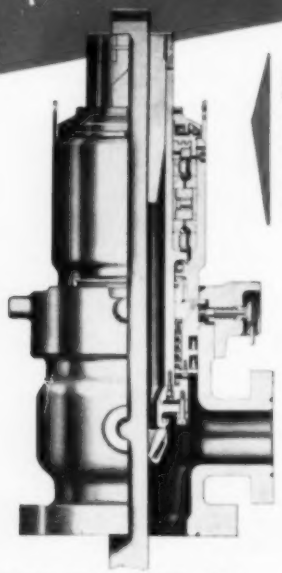
ONE OF THESE

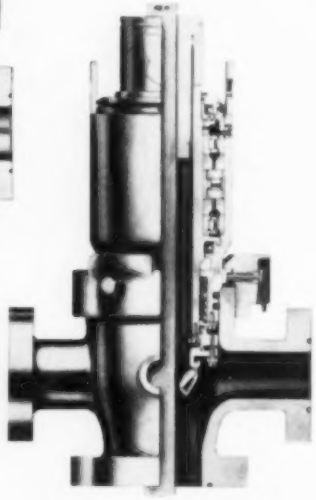
SHAFFER COMBINATION ROTATING BLOWOUT PREVENTERS AND STRIPPERS

fits your particular pressure control requirements!



USE THE TYPE 50

for all kinds of drilling operations, including drilling through 10¾" casing and larger.



USE THE TYPE 51

for blowout protection in slim hole drilling, drilling-in, production jobs, reworking of wells and similar applications.

Shaffer Combination Rotating Blowout Preventers and Strippers are known throughout the industry for the unequalled *automatic* protection they provide against pressure emergencies. Nothing to remember—or forget—when pressure emergencies threaten, because this equipment automatically seals off around the drill string as the tools are lowered into the well . . . *and maintains this pressure-tight seal—without attention—throughout all subsequent drilling operations.*

Whether for big jobs (Type 50) or small (Type 51), both types can be used for the various applications outlined at left.

See your nearest Shaffer representative for complete details on these units. Or write direct.

Send for your free copy of the complete Shaffer Catalog.

See the Shaffer Section of your Composite Catalog.

Most powerful drilling barge yet built

6000-Horsepower Designed in "Mr. Gus II"

C. G. Glasscock Drilling Company's new diesel-electric mobile unit to meet all power demands

THE most powerful diesel-electric power plant ever assembled for offshore drilling will be mounted on the "Mr. Gus II," a giant new mobile drilling platform being built in Beaumont, Texas, for the C.G. Glasscock Drilling Company of Corpus Christi, Texas. Providing a maximum of 6000 hp for drilling operations, the barge is reported to be a three-story platform that will dwarf anything now used in offshore operations. Plans call for this new mobile platform to be placed in service in February or March of this year.

Similar in design to the first C. G. Glasscock platform, "Mr. Gus," the new barge will have almost 2000-hp more than this original unit and is designed for ultra deep drilling operations. The first Glasscock unit has been in service for two years and has made quite a record in deep water operations. It recently completed its ninth well which was drilled in 87 ft of water almost 70 miles offshore. The new mobile platform will be considerably larger and will be capable of probing for oil and gas in approximately 140 ft of water.

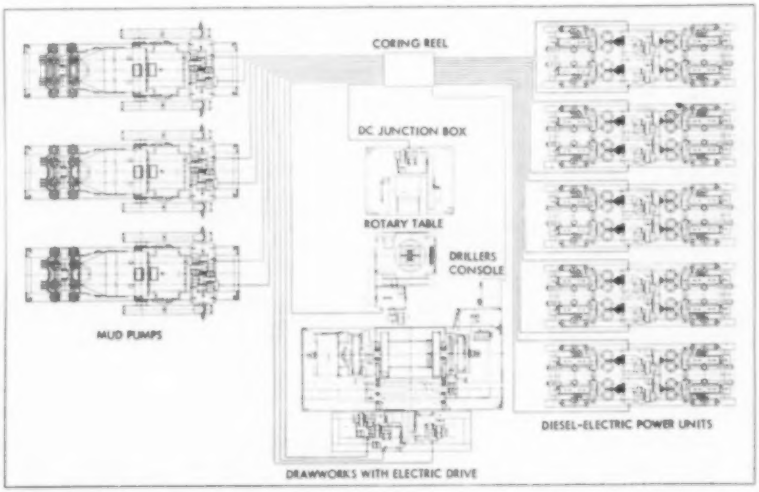
Power output on the new offshore unit will be 6000-hp maximum for the drilling equipment with additional power for auxiliaries exceeding 1500 hp. Primary power will consist of five 1200-hp packages composed of two 600-hp d-c generators driven by four diesel engines. Arrangement is such that all four of the engines or any one engine can power any one or both generators simultaneously. Totaling 20 engines and 10 generators, the system provides an extremely reliable power supply for drilling operations.

Drawworks on the "Mr. Gus II" is driven by three electric motors with a combined capacity for hoisting of 2700 hp. Mud system is equipped with three mud pumps, each of which is powered by dual electric motors having a combined rating of 1200-hp in continuous service. The rotary table as well as the coring reel are driven individually by d-c electric motors.

Auxiliary power system for lighting and driving rig auxiliaries is powered by three 300-kw a-c diesel generator sets.

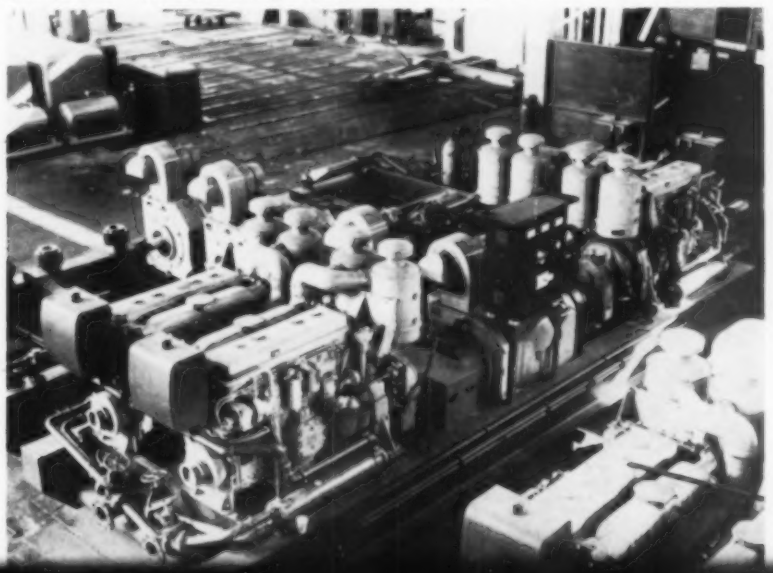
Acknowledgment

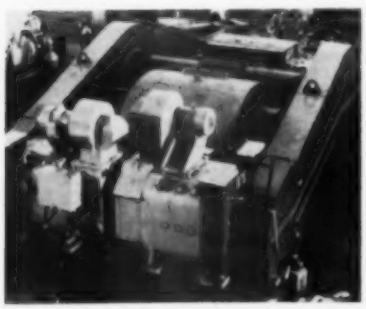
Photographs, diagrams and information on diesel-electric installation on "Mr. Gus II" from material released by Stewart & Stevenson Services, Inc., Houston, Texas. ★ ★ ★



Diesel-electric installation for "Mr. Gus II." Driller controls up to 6000-hp maximum to drawworks, rotary table, coring reel, and mud pumps from a central control console.

Primary diesel-electric power pack consists of five units, each consisting of two 600-hp d-c generators and four diesel driving engines. Additional power for auxiliaries exceeds 1500 hp.





Three 1000-hp mud pumps are each driven by dual motors with a combined rating of 1200 hp for continuous service.

Here is a new full-revolving, stationary-mounted crane — the UNIT Mariner — specially designed for off-shore drilling operations. Conceived, developed and perfected by UNIT, the Mariner meets all requirements for cargo handling from a fixed mounting as applied to ships, barges or off-shore platforms. Unlike conventional cranes, the Mariner emphasizes unusual strength in turntable, roller path, rollers, hook shoes, boom and hoist mechanism.

A special, heavy-duty "A" frame permits capacity loads with extended boom at long radius. The famous UNIT sealed cast gear case serves as a protection against salt spray.

SAFETY is a major feature. Incorporated in the Mariner design, are positive and mechanical boom stops. These boom stops control the angle of elevation and prevent the boom from whipping back. Also the safety-promoting Full Vision Cab enables the operator to see what he is doing at all times. Load ratings are based on high factors of safety.

Yes, the Mariner is designed primarily for your type of cargo handling. Get the facts. Send for bulletin — NOW.

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Geared to boost your earnings!

McLemore Elected Otis President

Robert H. McLemore, former vice president and general manager of the Turbodrill division of Dresser Industries, and one of the founders of Welex Jet Services, Inc., was elected president of Otis Engineering Corporation of Dallas, Texas, and its subsidiaries, effective early January, 1957.

H. C. Otis, president and founder of the 30-year-old firm, was elected to a newly created position of chairman of the board of directors. Herbert C. Otis, Jr., formerly executive vice president and secretary of the corporation, was elected first vice president and secretary.

Otis Engineering manufactures subsurface tools and equipment for high-pressure oil and gas wells. It is the parent company of Otis Pressure Control, Inc., sales and oil well service subsidiary.

McLemore has been a member of the Otis board of directors for some time, although there is no financial association between Dresser and Otis, either past or future, officials said.

Other officials of the Otis firms are W. E. Rich, vice president and treasurer; L. M. Wilhoit, vice president, in charge of engineering, and H. B. Schramm, vice president and director of development and manufacturing.

Otis Engineering Corporation is also the parent company of Otis Pressure Control Export, Inc., Canadian and European sales and service, and Servicio Tecnico de Pozos "Otis" C. A., South American sales and service outlet. The firm also has representatives on the East and West Coasts and in the Rocky Mountain Region.

Bob McLemore, newly-elected Otis president, center, confers with H. C. Otis, right, chairman of the board of directors for the Otis Companies, and Herbert C. Otis, Jr., left, first vice president and secretary of the Dallas firm.

In 11 months' continuous operation, no down time and no expense on this Dependable Wheland HP-8000 Pump !

Installation view of the Wheland HP-8000 owned by Virgil Taylor Drilling Co., Gainesville, Texas. Left to right: Mr. Woody Atkins, Tool Pusher; Mr. Virgil Taylor; Mr. Walter Smith, Drilling Supt.

WHELAND HP-8000
DUPLEX SLUSH PUMP
7¼" x 12"
220 HP at 70 RPM

Known throughout the oil fields as

"the biggest little pump on the market"

"We are happy to recommend the Wheland pump," says owner operating his second.

"Since . . . last January . . . have been running this pump within 10% of its efficiency. We have had no down time and no expense . . . during this time."

Wheland builds a Complete Line of Efficient Slush Pumps. **Write for Descriptive Bulletins.**

VIRGIL TAYLOR — WALTER L. SMITH — R. B. THEON

VIRGIL TAYLOR DRILLING COMPANY
POST OFFICE BOX 76
GAINESVILLE, TEXAS

November 15, 1956

Mr. Gordon P. Street, President
The Wheland Company
Chattanooga, Tennessee

Dear Mr. Street:

We purchased a Wheland HP-8000 Pump last January which has been in continuous operation since that time. We have been digging wells from 3,500 to 5,000 feet and have been running this pump within 10% of its efficiency during this work. We have had no down time and no expense against this pump during this time.

We had one of your old-style HP-11000 Wheland pumps in operation for a period of seven years. It is surprising to realize the amount of hole that it did with very small expense. We are happy to recommend the Wheland pump.

We operate two rigs in North and West Texas and in Southern Oklahoma, digging wells from 2,000 to 8,500 feet. We do contract drilling, take interest deals and drill for our own account.

Yours very truly,

VIRGIL TAYLOR DRILLING COMPANY

By Virgil Taylor
Virgil Taylor

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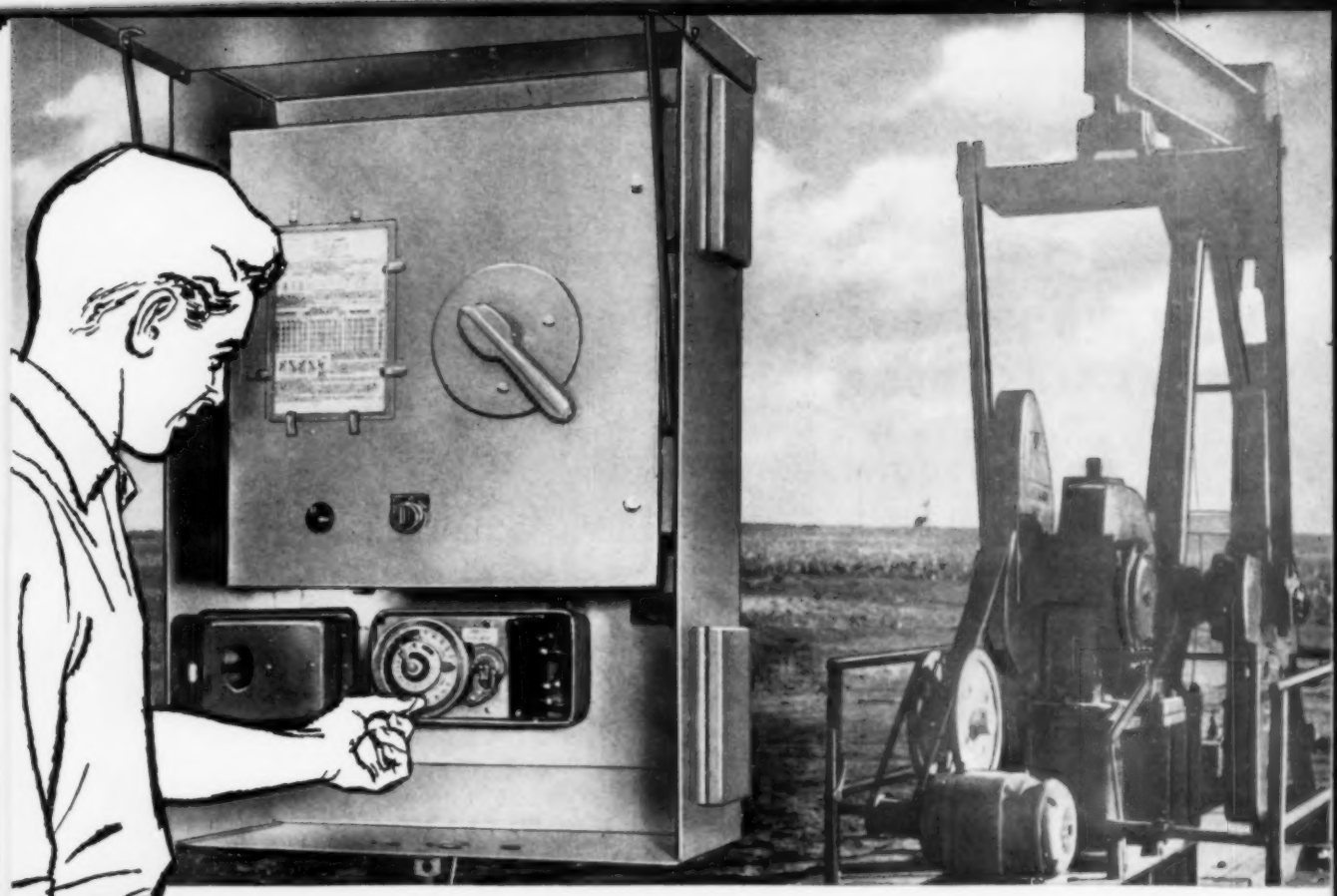


"Practically thinks for itself"

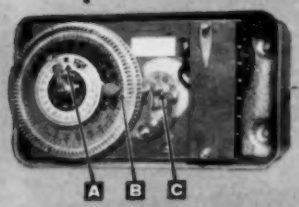
The new Cutler-Hammer Three-Star Oil Well Pumping Control has performed so successfully and proven so completely dependable that the leading oil field men everywhere insist on C-H control for all their pumping wells and accept no substitutes. Ask these men why and they will tell you, "That new C-H three-star control beats them all. No matter how tough it gets, our pumps keep pumping; and that Supertimer practically thinks for itself." Your first pumping well equipped with Cutler-Hammer control will prove to you what these men know... Cutler-Hammer Three-Star Oil Well Pumping Control will out-perform, out-protect, out-last and serve better than all others.

This control has *everything*, particularly the engineered dependability so vital in any automation... nothing is left to chance. Insist on the finest, insist on Cutler-Hammer... leading manufacturer of *automation* control.

Your nearby Authorized Cutler-Hammer Distributor is stocked and ready to serve you. Order from him today. CUTLER-HAMMER, Inc., 1459 St. Paul Avenue, Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

Member American CUTLER-HAMMER ★ ★ ★ MOTOR CONTROL C-H *Petroleum Institute*

New CUTLER-HAMMER Supertimer



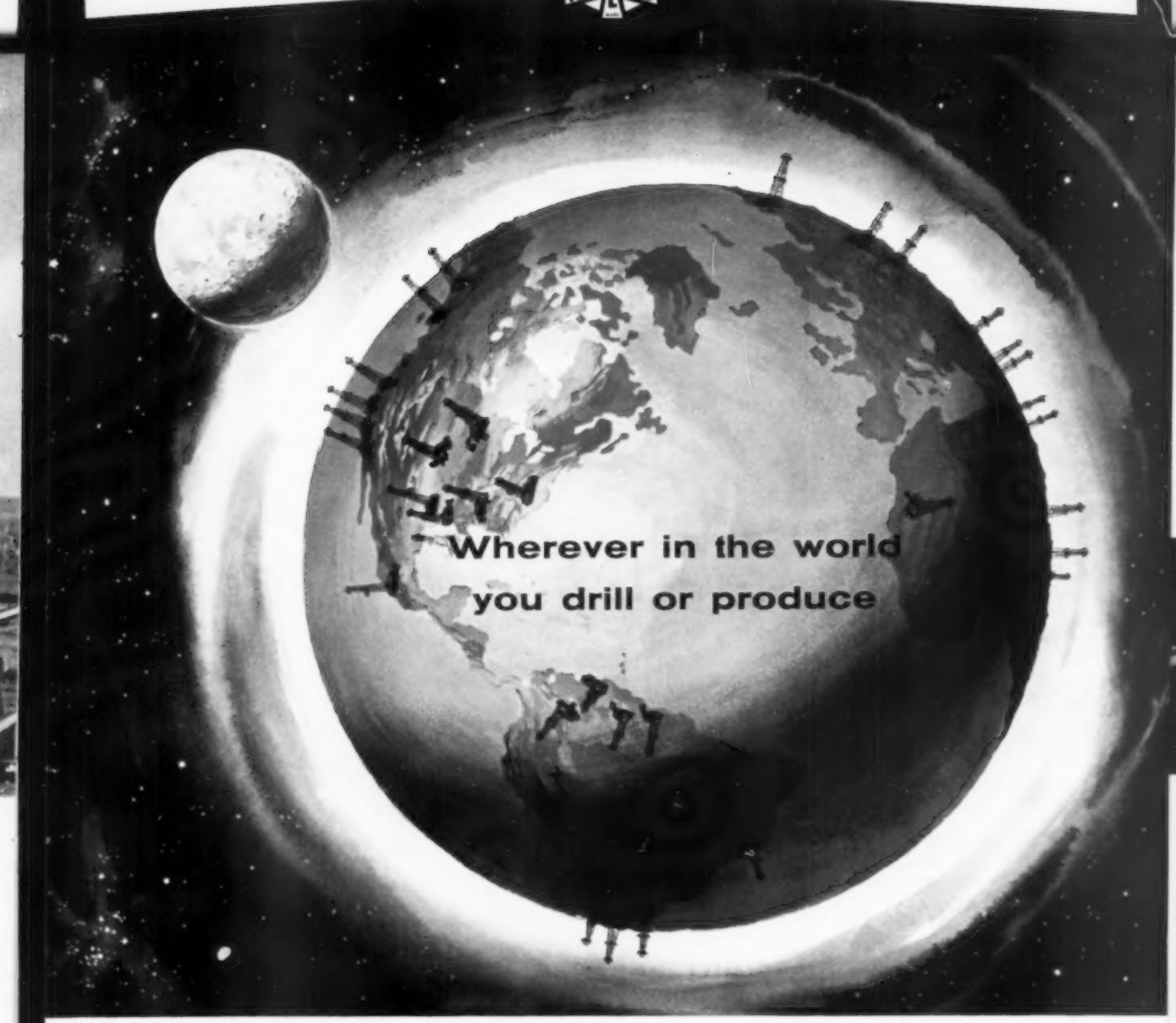
This is *automation* in action. You pre-set the Supertimer to meet your field allowable and the control will do the rest, automatically. It starts, stops, restarts and cycles indefinitely, precisely according to your schedule. If a power outage occurs, any number of C-H controlled pumps can be restarted in an exact sequence to avoid overloading the power lines on inrush. Unfortunate coincidental starting of even two pumps is impossible.

- **A** Sets the precise restarting time delay from zero to 180 seconds. This is exclusive with the Supertimer—random starts or coincidental starts of even two pumps are impossible.
- **B** Sets the daily pumping schedule—pull a tab for each fifteen minutes of pumping, space them through the daily 24 hour period as desired.
- **C** Sets the weekly pumping schedule—1, 2, 3, 4, 5, 6 or 7 days per week as desired.

COMPLETE PROTECTION
The control is protected against lightning with exclusive, advanced-designed lightning arresters; and the three coil overload relay protects the pump motor from overloading and dangerous single phasing which often results from lightning.

CHIMNEY DRAFT VENTILATION
The heat-reflecting, aluminized enclosure insures a constant circulation of air... no nuisance tripping because of trapped heat.

DUST SAFE CONTACTS
Dust-Safe vertical contacts stay clean and eliminate the necessity of contact replacement common to other designs.



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Cement-Lined Pipe Gives 20-Year Service

Pipe used in Oklahoma waterflood since 1935, recently dug up, will be used in new Forest Oil Corporation project

A few months ago near Nowata, Oklahoma, workmen of the Forest Oil Corporation began digging up some cement-lined pipe that had been in the ground for 20 years.

They didn't expect the pipe to be of much value because, after all, it had been put to the severest use one could imagine. The subterranean water used by Forest Oil in its secondary recovery project contains salt, hydrogen sulfide and other corrosive materials that will eat through ordinary pipe in as little as six months.

The pipe that was being dug up had something of a nostalgic interest to the Forest Oil people because it had been used in their first waterflooding project in the area. Flood No. 1 they called it, and each new project opened up has been numbered consecutively since. Forest Oil, which has its headquarters in Bradford, Pennsylvania, pioneered the systematic waterflooding method.

"Excellent" Shape

When the cement-lined pipe was taken from the ground, it was examined carefully and found in "excellent" shape. In fact, the pipe was in such good condition that it could be used in Forest Oil's newest project, Flood No. 32.

"Frankly, I don't know what we would have done without cement-lined pipe," said Arthur L. Robinson, vice president and general manager of Forest Oil's operations in Oklahoma.

"The water we have had to use here is just about as corrosive as anything I've ever come across. And yet we are still using some of the same cement-lined pipe that we installed back in 1935," Robinson added.

Forest Oil uses a lot of cement-lined pipe. During the first six montns of 1956 — a period in which the company had not been particularly active — they purchased 150,000 ft from a steel producing company.

Forest Began in 1935

When Forest Oil began its secondary recovery operations near Nowata in 1935, such projects were pretty much of a haphazard thing in that area. Forest was among the first to set out to get the oil yet remaining in abandoned fields there. The company did it systematically and it has paid off.

Derricks that once dotted the landscape in the oil fields near Nowata were gone when Forest moved in. The oil boom of 1910 was only a memory.

The oil had come out of the earth easily in those boom days. So easily in fact that when the flow slowed down, the oilmen though that the field was exhausted. It took some men of ingenuity to prove it. And prove it they have, to the tune of millions of barrels of oil that otherwise might never have been brought to the surface.

The secondary recovery of oil by waterflooding was not a new concept in 1935, especially for the Forest Oil Corporation. In fact, it was first used around the turn of the century in the Bradford, Pennsylvania, field. It is believed that this method was first discovered by the accidental flooding of oil sands when water was improperly excluded from the wells.

New Operations

Work that is now going on at Forest's Flood No. 27, 10 miles out of Nowata, is typical of today's operation. Cement-lined pipe is being used in the project.

Floor No. 27 has been in operation about six years and has produced over a million barrels of oil. It is located in the Curl Creek field and the Bartlesville sand, at a depth of 1050 ft. The formation is 25 ft thick.

Flood No. 27 has about 150 water injection wells in operation, although the number is added to regularly as the leasing expands.

In a typical pattern, a well is drilled on the four corners of a square. The sides of the square are 330 feet long. Water is pumped at 750 lb pressure into the four wells. In the center of the square, a production unit or pumper, is put into operation. The water spreads throughout the oil bearing formation until it reaches the center of the square where it is pulled out by the pumping units.

At the beginning of the flood, the oil is pushed ahead for a while and the pumper will bring up almost pure oil. Later, however, production may drop off to eight parts of water to one of oil. But this will go on for many years.

Forest Oil's total production around Nowata is in the neighborhood of 3000 bbl a day.

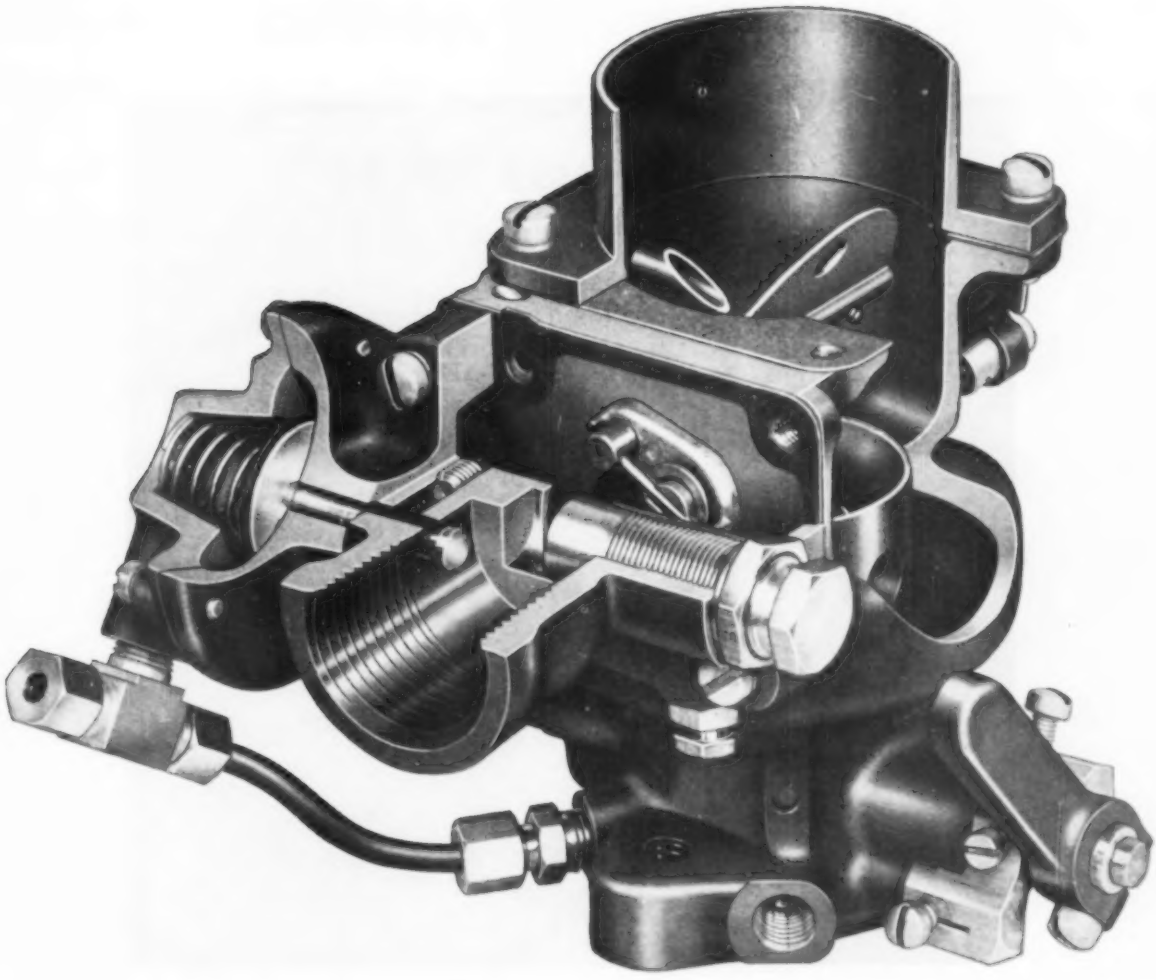
The one crimp in the waterflooding system is the lack of surface water.

Consequently, Forest Oil has had to drill down to the Mississippi limestone formation at about 1900 ft to get the necessary water to use for secondary recovery.

Cement-lined Pipe—Exclusively

From the time it leaves the treating station until it is pumped into the wells, the water travels exclusively in cement-lined pipe, ranging in size from 1½ to 6 in. Even the fittings are cement-lined.

When water and oil mixture is pumped out of the hole it is transported in cement-lined pipes from the production unit to tank batteries.★ ★



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More than just a series of interconnected metal loops . . .

What you should know about OIL FIELD CHAIN

Proper selection from four grades can save money on specific applications

Harry Reid
Chief of Development, The McKay Company, Pittsburgh, Pennsylvania

PROPER selection of the most suitable grade of chain for each specific application can cut chain costs to equip and maintain drilling and hauling operations. Boomer chains, spinning chains and winch line tail chains are the most frequently used.

Despite familiarity with chain, it is not widely known that there are four grades of proof-tested steel chain. Each grade has specific working properties and limitations. A change in rated capacities of these four grades was

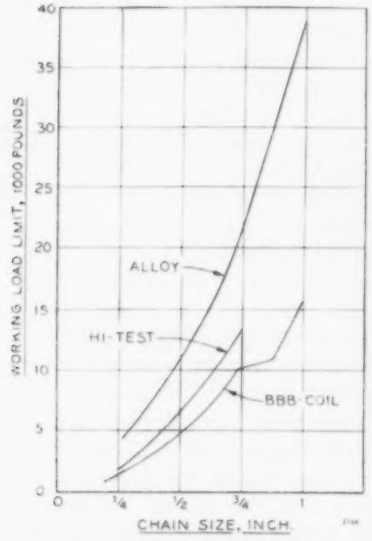
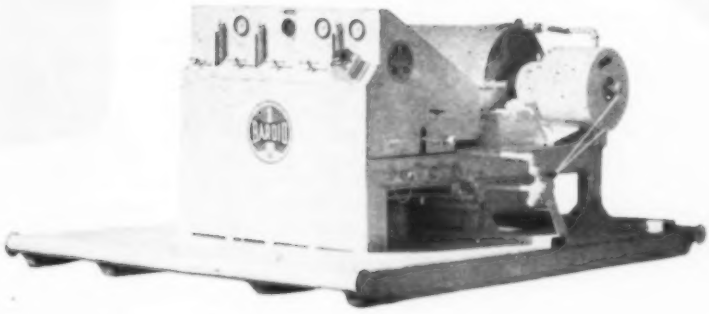


FIG. 1. **Working load limits** vary considerably for the four most common oil field chains. Limits for proof coil chain, not shown here, are about 10 percent lower than the BBB coil chain.

FIG. 2. **Chain hoists** use two different types of chain — high test chain for holding the load, while the hand chain is generally made from mild steel.



BAROID'S new mud centrifuge

CUTS YOUR MUD COSTS BY:

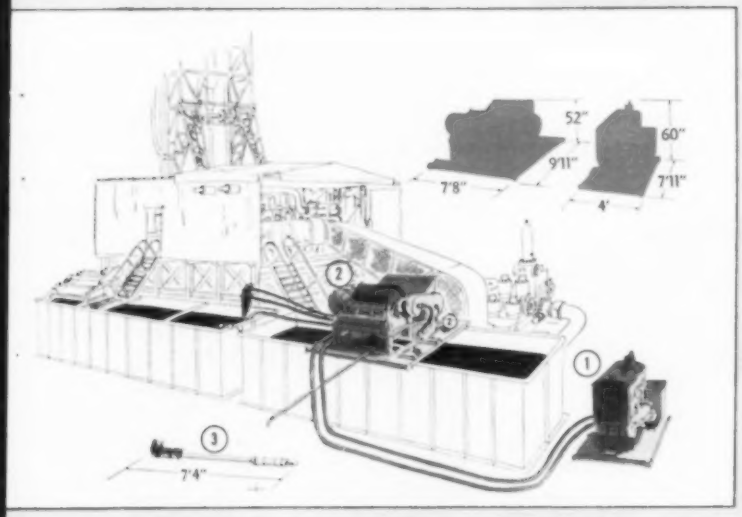
- **The efficient recovery of valuable mud materials**
- **The rejection of unwanted solids**
- **Better control of viscosity, gel, filtration rate, and cake thickness**

Installations on the Gulf Coast have shown the Baroid Centrifuge can save up to *four times* its daily cost through reduction of expense for weight materials.

Mounted at your mud tank or pit, the new Baroid Centrifuge discards drilled solids and fluids from valuable mud weight materials. Clays are the reason for needing chemical treatment, and the Baroid Centrifuge reduces this need by getting rid of the clays. The Baroid Centrifuge handles up to 35 barrels of mud per hour.

You gain better control of viscosity, gel strength, filtration rate, weight, and cake thickness by use of the Baroid Centrifuge. It reduces water dilution needs, handles lost circulation materials, and aids in removing soluble contaminants or spent chemicals.

Weight material recovery efficiency of as high as 99% and clay rejection of as high as 60% have been achieved on one pass of the mud through the Baroid Centrifuge! Write for complete data and specifications.



Simple and trouble-free, the Baroid Centrifuge consists of three units: (1) a skid mounted engine and hydraulic pump to furnish power, (2) the skid mounted centrifuge, and (3) the portable mud pump. The Baroid Centrifuge operates on gasoline, natural gas or butane. If requested, a diesel engine can be furnished with the power unit. It requires no electrical equipment, and safety features are included to prevent damage to equipment by loss of coolant or overloading. Use it also to reclaim discarded weight materials, as a desander, or to remove gas from gas-cut muds.

BAROID

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Gentlemen: Please send me data on the Baroid Centrifuge.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

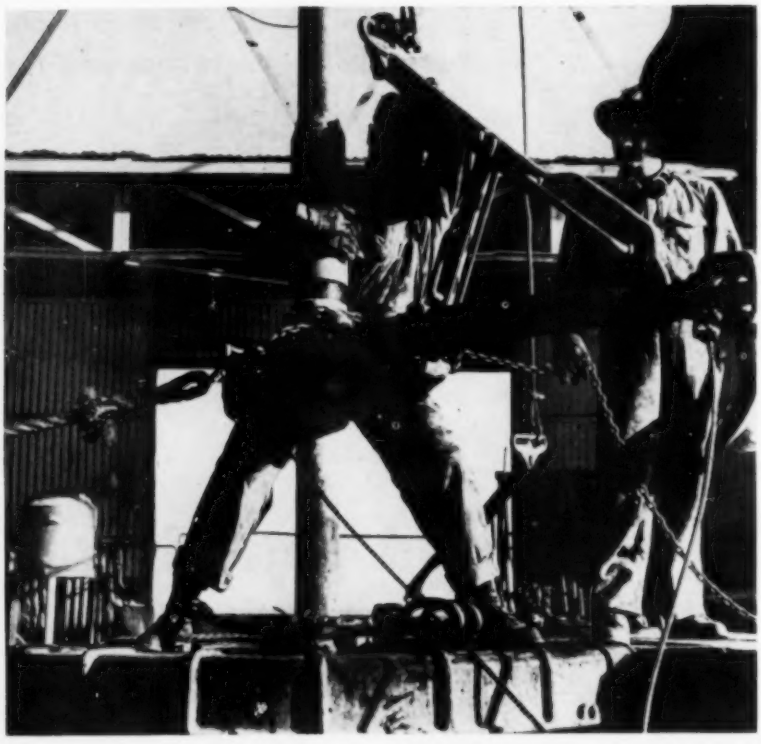


FIG. 3. **Spinning chain** used by drilling crews have short links giving maximum grasping power and ease of operation.

adopted recently on an industry-wide basis by all chain manufacturers.

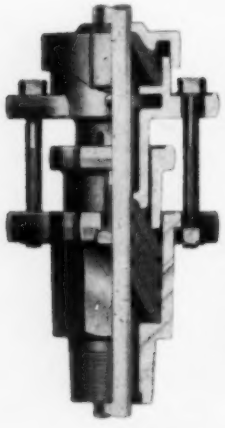
General Properties

Bulk of the chain requirements for oil field applications are met by BBB coil chain, hi-test or high-carbon chain, and alloy chain. A few operators prefer to use proof coil chain as a substitute for BBB coil chain. Size for size, ratings for proof coil chain are approximately 10 percent lower than those shown for BBB coil chain in Fig. 1.

Chain is rated in terms of the working load limit. Working load limit is defined as: *"The maximium load in pounds which, at any time or under any condition should ever be applied to the chain — and when the load is applied in direct tension to a straight length of chain."*

All of the grades of welded chain described in this article are proof-tested in direct tension under a load equal to at least 200 percent the working load limit. This 100 percent overload-test is applied to each foot of chain prior to final inspection and shipment.

It should be emphasized again that each of the foregoing properties of chain are based on uniform loads in direct tension. Unequal stress distribution and impact loading can exert forces on the chain equal to several times that of the actual load involved. In most



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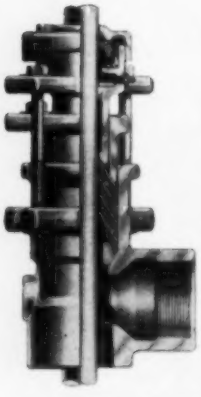
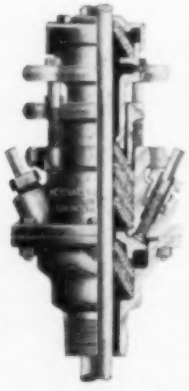
The old reliable, tried and proved on thousands of wells from coast to coast and in foreign fields.



"TEE BASE TYPE" DUPLEX POLISHED ROD STUFFING BOX

A combination Stuffing Box and Pumping Tee. Makes a short connection. Bolt lugs are placed low to eliminate fouling of elevator links. No bell nipple needed as top of body will support elevator. Full opening — unnecessary to remove body when pulling or running rods.



"TYPE DP" DUPLEX POLISHED ROD STUFFING BOX

A Double Packed Stuffing Box for use on high pressure wells and those that flow intermittently. Especially desirable for wells located near buildings, fire hazards of growing crops. Two compression bolts, in bottom sections, are tightened on Cone Rings to pack-off while replacing packing in upper section.

All HERCULES Stuffing Boxes are made of high grade malleable iron which prevents shattering if rods drop. They are tested to 3,000 pounds psi pressure and all use the famous HERCULES Split Cone Packing Rings.

HERCULES OIL RESERVOIR UPPER GLAND

* All HERCULES Stuffing Boxes may be equipped with Oil Reservoir Upper Glands on "problem" wells which pump-off and burn the packing. The polished rod moves through the oil in the reservoir which lubricates and cools it.

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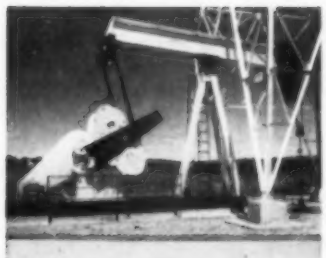

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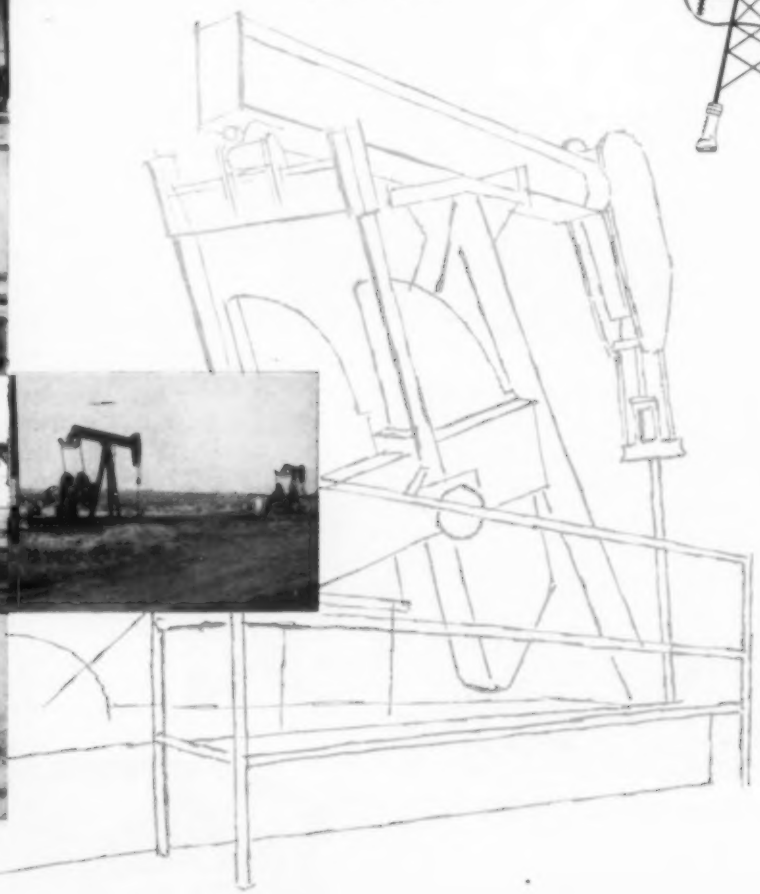

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Trade Mark
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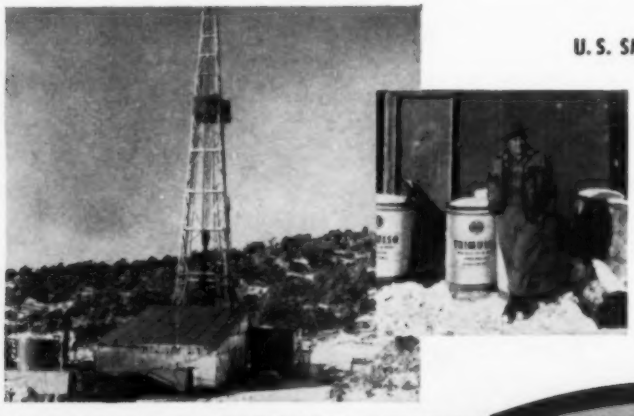
with this field-proved oil emulsion drilling fluid . . .

- **Used successfully in over 500 wells**
- **Drills more feet per hour**
- **Reduces torque and corrosion**
- **Unaffected by hardness or brine content of water**
- **Mud viscosity easily decreased or increased**
- **Non-foaming; doesn't need constant attention**

TRIMULSO* emulsion mud, made with Aquaness emulsifiers, is the original high speed drilling fluid emulsifier. It is paying off in faster, trouble-free drilling in hundreds of wells, in many different formations. For full facts, write to Baroid or call your local Baroid service man.



U. S. SMELTING, MINING & REFINING COMPANY REPORTS

trouble-free hole in Federal MacIntyre No. 1, near Craig, Moffat County, Colorado, being drilled by Signal Drilling Company with their Rig No. 2. They used TRIMULSO emulsion from 3000 feet. Numerous drill stem tests were run, and E. F. "Buck" Lain, toolpusher, says he had "no hole trouble." The photograph was taken at 6500 feet, and projected depth of well is below 11,000 feet.

LOOK FOR THE AQUANESS SEAL

. . . it identifies the original high speed drilling fluid emulsifier, made by Aquaness to highest standards of uniformity for leading mud companies.

ATLAS

Aquaness *Department*

ATLAS POWDER COMPANY

2005 Quitman Street, Houston 26, Texas

such cases, it is impossible to predict the load placed on the chain. Therefore, safe operations demand that such undetermined loading should be avoided wherever possible.

Low Carbon Steel Chain

Proof coil and BBB coil chain are manufactured from chain-quality, low-carbon steel. These may be manufactured automatically by electric-welding or hand-made by firewelding. Firewelding is a process in which skilled artisans heat and forge-weld individual links into high quality chain.

BBB coil chain is the strongest grade of non-heat-treated chain being produced today. Link configuration is shorter and narrower than that of the same size of proof coil chain. Size for size, the narrow, compact link pattern provides greater resistance to permanent deformation under excessive loads and greater flexibility than obtainable using proof coil chain.

Recent improvements in manufacturing practice and improved techniques for welding this low-carbon material have enabled chain manufacturers to revise upward the safe working load for many sizes of proof coil and BBB coil chain without decreasing their safety factors. The magnitude of these increases is shown in Table 1.

Proof coil and BBB coil chain find a wide variety of uses in normal field operations. Purchased in running lengths, they become the general utility chain and are ideally suited for those applications where the undetermined characteristic of the loading threatens to destroy the chain the first time it is used. Neither of these grades of chain are recommended for hazardous, overhead lifting operations.

Proof coil and BBB coil chain normally are purchased in bulk. The running lengths of chain are cut to size on-the-job. Attachments are added or assemblies produced using one of the several types of non-welded connecting links. Manually arc or gas-weld connecting links frequently are employed.

Low-carbon chain normally is supplied in the self-colored condition.

TABLE 1—Recommended Working Load Limits for Low-Carbon Steel Chain.

Chain Size, in.	Proof Coil Grade		BBB Coil Grade	
	Revised, lb	Former, lb	Revised, lb	Former, lb
3/16	575	525	675	650
1/4	1175	900	1325	1150
5/15	1750	1400	1950	1700
3/8	2450	1900	2750	2350
7/16	3250	2530	3625	3150
1/2	4250	3300	4750	4150
9/16	5250	4100	5875	5150
5/8	6375	5000	7250	6250
3/4	9125	7100	10250	8850
7/8	9600	9600	12000	12000
1	12400	12400	15500	15500

(Advertisement)

Upper section of world's longest sub-surface rod pump is raised by pulling machine. Two units were made up at stuffing box, then lowered into well and seated as a single pump.

80' – Longest Ever Run

H-F "Double-Displacement" Rod Pump Increases Oil 130 B/D

An 80-ft. Harbison-Fischer Double-Displacement® Rod Pump — the longest sub-surface pump ever built — is successfully operating in West Texas and has increased production a whopping 130 Bbl./day. Operator ran the Double-Displacement® Rod Pump rather than pull the production string and install a tubing pump to handle the necessary fluid volume to make the allowable. Although the Double-Displacement® is a regular insert-type pump run on rods, the unit will handle more fluid than a comparable-sized tubing pump.

The Double-Displacement® pump is now making approximately 775 Bbl. of fluid per day on a 26-ft. stroke hydraulic jack. The well is a dual-completion, the Devonian flowing through the casing and the Ellenburger pumping through 2½-in. tubing from perforations below 10,000 ft.

The previous pump was a 2½"x1¾"x 40' rod pump which only made 90 Bbl. of oil to 290 Bbl. of water on 5 26-ft. S/M. The 2½"x2"x2"x80' Double-Displacement® Rod Pump increased the oil production to 220 Bbl. of oil and 555 Bbl. of water on 4½ 26' S/M. Owing to the length of the pump, the assembly was raised in two sections, made up in the well, and then run to bottom as a single unit. The pump was set at 6,000 ft., using a conventional cup-type bottom hold-down.

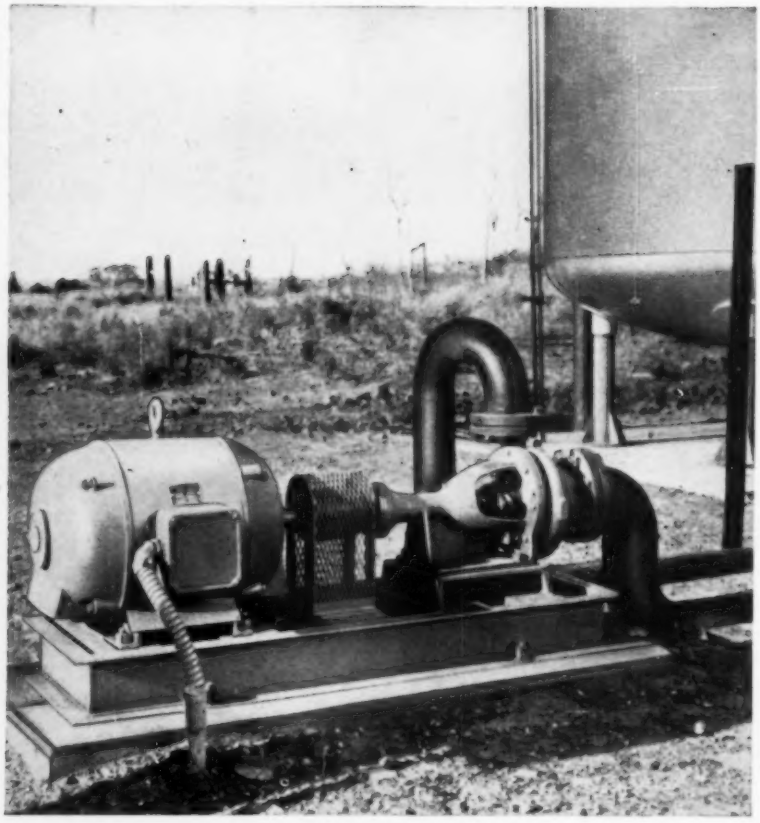
Other than the unusual length, the pump was of a standard Double-Displacement® design, the same as regularly available through leading supply stores in all major producing areas.

The Double-Displacement® pump is an insert-type, traveling barrel, bottom hold-down assembly made up of two plungers and two barrel tubes which work simultaneously with a single set of valves. In operation, the assembly produces as two separate pumps made up in tandem which virtually doubles the volume of the unit as compared to the displacement of comparable-sized conventional pumps.

The producing situation of the West Texas well was one of two identical conditions for which the Double-Displacement® pump is recommended by the manufacturer: To move more gross fluid, or the same fluid volume at slower pumping rates. In either case, the Double-Displacement® Rod Pump will produce the desired amount of fluid without the operator's having to install a larger bore pump.

The only successful tandem rod pump ever designed, the Double-Displacement® pump was patented by Harbison-Fischer and has been on the market several years. Hundreds are in daily operation in fields throughout the Mid-Continent and Gulf Coast areas.

The pump is available in a wide range of metal-to-metal, H-F "Flexite"®, or soft packing plungers with chrome-plated or heat-treated barrel tubes in 2"x1½", 2½"x2", 3"x2½", and 4"x3¼" sizes. Illustrated literature and comparison data are available without obligation from Harbison-Fischer Mfg. Co., P. O. Box 127, Fort Worth, Texas, or from any of the firm's factory representatives throughout the oil patch.



A Centrifugal Pump Salt Water Can't Damage!

Ampco Pumps are ideal for salt-water disposal and flooding operations:

- *Transfer service*
- *Pumping over aerators*
- *Pumping through filters*
- *Back-flushing filters*
- *Delivery of treated water*

It's an AMPCO . . . made from aluminum bronze that contains no zinc.

Ampco Pumps resist corrosion, erosion, abrasion, cavitation-pitting, and dezincification. They are made from Ampco alloys engineered specifically to resist salt water corrosion.

Durability isn't the only advantage of Ampco Pumps. They have high efficiency . . . up to 85%. You pay considerably less for power.

Ampco Pumps are available in more than 100 different combinations, with speeds from 1750 to 3500 rpm; capacities to 600 gpm; heads to 300 feet.

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AMPCO METAL, INC.

Dept. PE-2, Milwaukee 46, Wis. • West Coast Plant: Burbank, Calif.

THE METAL WITHOUT AN EQUAL

P-23

Special finishes may be obtained for specific service applications. Hot-galvanized chain is used for those applications where the corrosive action of salt water constitutes a problem. Carburized or case-hardened chain provides greater resistance to abrasive wear than normally associated with conventional proof coil or BBB coil chain.

Hi-Test Chain

Hi-test or high-carbon chain is produced from C-1017 or C-1020 steel in much the same way as chain produced from low-carbon material. It should be pointed out in passing that the designation of a C-1020 steel as high-carbon material is a chain industry usage and is in sharp contrast to the carbon content of other truly high-carbon sheet and plate used in field operations.

After welding, low-carbon steel chains are ready for final testing, inspection, etc. At this point, however, the manufacturing cycle for hi-test chain is just well underway. Welded chain is normalized to reduce any locked-up stresses produced by the initial forming and welding operations. The soft hi-test chain then is hardened and tempered to produce the desired combination of tensile strength and ductility, i.e. ability to stretch under excessive loads that exceed the yield point of the chain. At the completion of each stage of the heat treating cycle, sample lengths of chain are tested to destruction. This control test procedure provides a measure of effectiveness of the individual heat treating operation and thus helps insure quality and uniformity of the finished product.

After heat treatment, high-carbon chain material has a tensile strength of about 85,000 psi. This is a sharp increase over the approximately 55,000-60,000 psi material used in the manufacture of low-carbon steel chain. This increase in strength of the chain material is reflected in substantially higher working load limits for each size of chain.

Like the low-carbon steel grades of chain, the working load limits of hi-test chain also were revised recently. Unlike proof coil or BBB coil chain, the values for hi-test were reduced somewhat as shown in Table 2. This

TABLE 2—Recommended Working Load Limits for Hi-Test Chain.

Chain Size, in.	Revised rating, lb	Former rating, lb
1/4	1875	2500
5/16	2750	4000
3/8	3875	5100
7/16	5125	6600
1/2	6625	8200
5/8	9750	11500
3/4	13500	16200

VISQUEEZ
SLURRY

is shutting off water where all other methods have failed!

Your toughest water problems may be solved by this entirely new approach!

You now have available – with Visqueez service – the most effective method ever developed for eliminating water from a producing oil or gas well.

Visqueez provides these EXCLUSIVE advantages:

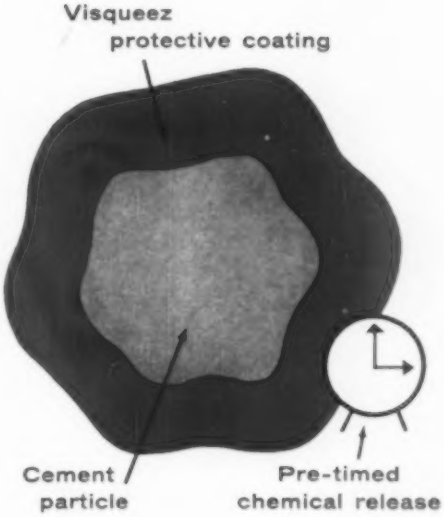
1. *Visqueez slurry thins on contact with water,* allowing easier and deeper penetration into the water-bearing sections. (Other slurries *thicken* on contact with water.)

2. *The setting time is controlled.* Visqueez slurry cannot set up after placement until a pre-timed chemical action removes a protective viscous coating from the cement particles, allowing water to contact and set the cement. The time lapse between placement and setting up will vary from 3 to 8 hours depending on type of cement and well conditions.

3. *Low fluid loss* minimizes the possibility of screen-out.

4. *Lower injection pressures* are possible and the usual final squeeze pressures are eliminated.

5. *Either common, slow or quick-set* cements may be used.



CHEMICAL PROCESS BJ Service

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apparent down grading of hi-test chain does not reflect any change in quality of the chain. The change in working load limits stemmed from a desire on the part of chain manufacturers to standardize production practices. Prior to this change, hi-test chain was the only grade of proof-tested steel chain not tested under a load equal to 200 percent of the working load limit. For hi-test chain, accepted proof loads represented an overload of about 70 to 75 percent. With the new ratings, hi-test chain may be proof-tested with the conventional 100 percent overload without danger of excessive deformation of the chain.

Hi-test chain frequently is used for those general purpose applications where its additional strength-to-size characteristics can be put to best use. Hi-test boomer chains and truck tie-down chains are popular. Hi-test winch line chains are standard products available from many supply stores. High test spinning chains are a special grade of hi-test chain made with an extra compact link for maximum flexibility in service.

Use of hi-test chain assemblies is split between those supplied by chain or equipment manufacturers and those made up in the field. Plant-produced assemblies have the advantage that the connecting or joiner links and frequently the end attachments can be heat treated to provide the same strength and margin of safety as that of the body chain. Assemblies safely may be made up on-the-job if care is taken to select a connecting link whose strength will match the strength of the body chain. Welding on hi-test chain or its heat-treated components should be avoided. Such weld metal and the adjacent heat affected areas will have properties different from those of the original heat-treated material.

Alloy Chain

Alloy chain is the strongest, toughest chain currently available. Made from selected grades of low-alloy, heat treatable steel, alloy chain follows the production cycle outlined for hi-test chain. The resultant heat-treated chain material has a tensile strength of about 125,000 psi and hardness of 25-27 Rockwell C. Alloy chain combines strength, abrasion resistance and ductility.

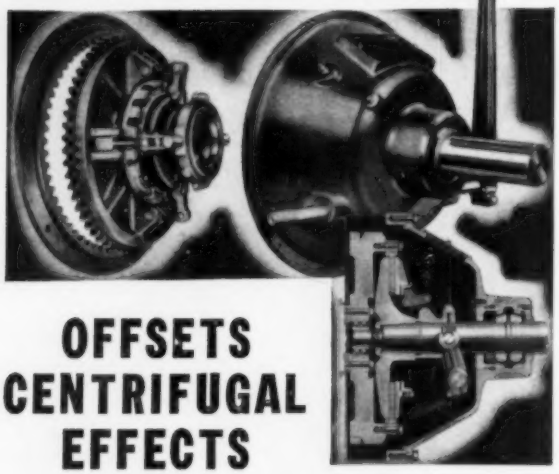
High working load limits of alloy chain frequently make it possible to reduce the size and weight of chain required for a specific application without decreasing the margin of safety. For example, referring to Fig. 1, ½-in. alloy chain has approximately the same working load limit as ⅝-in. hi-test or ¾-in. BBB coil chain. Decreased chain size and weight means greater chain mobility and frequently contributes to greater operating efficiency.

Alloy chain is the heavy duty chain of oilfield operations. Alloy spinning chain with its extremely compact link design provides maximum resistance to shock load and abrasive wear. Alloy boomer and tie down chains provide maximum strength with a minimum of dead weight. Alloy lifting slings are the only steel chain slings recognized by regulatory bodies for safe operation in overhead lifting applications.

Until recently, repair or make-up of alloy chain assemblies on-the-job presented a problem. Nearly all conventional connecting links lacked sufficient strength to match the strength of alloy chain. In recent months, however, a number of drop-forged alloy connecting links have become available. It now is possible to make up alloy chain assemblies using alloy connecting links and heat treated end attachments, with assurance that the finished assembly will have the same factor of safety as though the assembly had been made and heat treated by the chain manufacturer. ★ ★ ★

ROCKFORD

BALANCED CLUTCH LINKAGE



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Disengagement of the clutch in ROCKFORD Power Take-Offs is positive. It is accomplished by a linkage arrangement which is counterbalanced to offset the effects of centrifugal force—*prevalant in high-speed modern engines.* This is just one of several competitive advantages ROCKFORD Power Take-Off equipped engines provide.

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CLUTCHES

French Robertson Tells Servicing Contractors Of Texas Oil Future

The drilling of 23,000 wells at a cost to Texas operators of some $1.3 billion is a possible outlook for the state's petroleum industry in 1957, says French M. Roberton, president, Texas Mid-Continent Oil & Gas Association.

Robertson addressed a luncheon meeting of the Association of Oil Well Servicing Contractors, meeting in Fort Worth, Texas, January 18-19.

Robertson said a major portion of an estimated $3.7 billion gross income from Texas crude oil sales in 1957 would be plowed back into drilling and development work. He said the Texas drilling outlay may exceed that of 1956 by some $110 million.

He told contractors, however, that in spite of the recent price increase for crude oil, "the producers I know will still be shopping around for good prices for oil field service work. Many of them still feel that even the current prices for crude do not cover the kind of costs they are running into. They are also faced with many uncertainties. The biggest question, of course, is how the demand for domestic oil will hold up when the Suez crisis is resolved."

The outlook for exploratory and development activity in Texas is subject, Robertson said, "to continuation of current federal tax provisions affecting oil and gas, preservation of the state's conservation laws, and realization of predicted estimates of demand for U. S. Oil."

He said that "in spite of sporadic showers of brickbats blowing in from the north east aimed at Texas oil men, the state will continue to have the benefits which come from a lively petroleum industry operation."

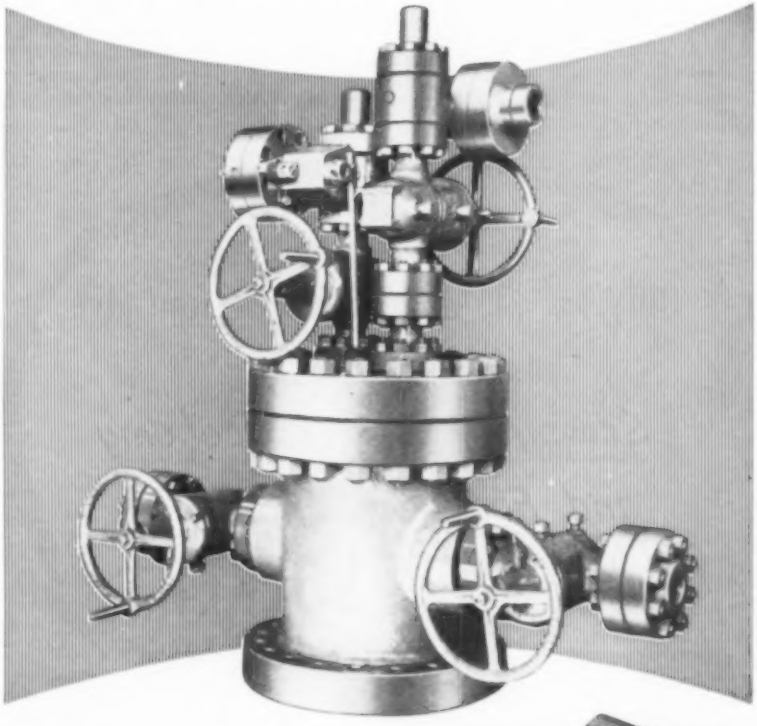
The speaker said that without income from Texas oil production, wider segments of the state's economy would face more complete ruination than already suffered as a result of the drought.

He called attention to royalty payments of some $500,000,000 a year for Texas landowners and other royalty owners, increased tax revenue, and strengthened leasing operations which are hinged to maintenance of oil production volume and prices through the year.

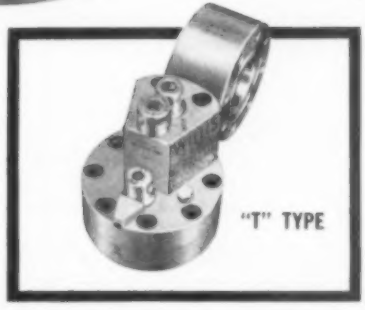
The independent oil producer said: "Probably the most important effect of Texas petroleum industry operations during 1957 will not be so much on the current year, but in times 5 or 10 years hence. The oil that is found today is the oil of Texas' future, as the production of today is that found, for the most part, more than 10 years ago."

ADJUSTABLE FLOW CONTROL

with pre-determined accuracy!



Simplify
Dual Completions
with
WILLIS
Rotary Adjustable Chokes



Willis Rotary Adjustable Chokes provide 6 different size choke inserts which are individually positioned in the line of flow by a fractional turn of the orifice—carrying disc . . . while under constant flow and high pressure. Simplicity of this uncomplicated Christmas tree (note deletion of wing valves) is accomplished by using a blank orifice in one of the 6 positions of the Willis Rotary Chokes for shut-in without closing the master valve.

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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

THE OASIS — *A gathering spot for NOMADS*

Herschel Lewis Leads Dallas-Fort Worth Chapter

Dallas and Fort Worth Nomads recently elected the 1957 slate of officers, picking G. H. Lewis as president for the coming year. Lewis is sales manager for the D + B division of Continental-Emsco.

R. E. Davidson was elected executive vice president; Harry Zane is the incoming vice president (Dallas) and Jerry Pinkard is vice president (Fort Worth).

Other new officers include R. B. Gilmore, secretary; Henry G. Streidl, assistant secretary; H. A. Davis, treasurer, and T. A. Ramey, assistant treasurer.

J. Lewis Foster is the newly elected sergeant at arms. Deputy sergeants at arms are Jack C. Norton and Webb M. Sowden. L. B. Meaders is senior regent and Abbott Sparks is junior regent.

G. H. Lewis, D+B sales manager of Continental-Emsco, is 1957 president of the Dallas-Fort Worth Chapter of Nomads.

1957 Houston chapter prexy is Tracy T. Word, Jr., of Thornhill-Craver Company.

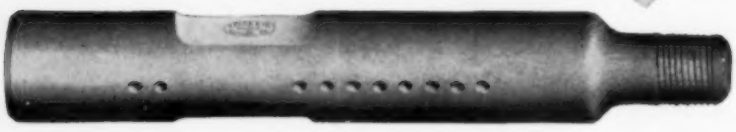
Dallas-Fort Worth Group Takes 12 New Members

In the past two months Dallas-Fort Worth Chapter of the Nomads has taken 12 new members. Meeting at the Dallas Athletic Club December 3, four new members were initiated. This group included Charles Breedlove, Collins Radio; Robert Egan, Wilson Manufacturing; Robert Evans, Byron Jackson, and Jim Hartzog, Ideco.

The welcome mat is also out for eight more new members accepted since the December 3 meeting. These neophytes are: I. D. Abshire, Weco; William Horner, Core Labs; John Wisenbaker, Core Labs; Steve Miranda, Dresser; Bob Brenner, Baash-Ross; James Thompson, Gulf Publishing; Jim Trail, Hyatt Bearing, and George Pfefferle, Dresser.

Only **SPANG** can give you the best in *Strength, Service, Economy and Footage* in a Prosser-type

SWIVEL ROPE SOCKET



There are times when an ordinary rope socket will meet your needs. But there are too many times when you can't afford to risk trouble—when you require a rope socket that's precision made and utterly dependable under all conditions. This is the time you'll be glad to have a Spang Rope Socket on the business end of your string—

• • • AND HERE'S WHY SPANG'S BEST

■ Completely Heat-Treated for maximum toughness and hardness ■ Precision machined ■ High steel strength ■ Extra strong joint ■ Carefully finished inside bore ■ Perfect setting for cable ■ Socket neck grooved for the use of fishing tools ■ Made by the country's oldest and largest manufacturer of cable tools

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For over 60 years Manufacturers of Spang Weldless Jars and a Complete Line of Cable System Drilling and Fishing Tools for Oil and Gas Wells, Water Wells, Prospect Drilling and Shot Blast Holes.

HALLIBURTON'S
SANDOIL FRACTURING

world leader in production stimulation

THE FACT

Sandoil has been successfully used on a greater number of oil and gas producing wells than any other fracturing process.

THE REASONS

- Economy encourages extra big fracturing jobs that create greater subsurface drainage systems. The fracturing fluid is inexpensive refined or crude oils which are available world wide.
- Convenient—no gelling additives needed.
- World's best qualified service operators—with most years of fracturing experience.
- Continuous high-rate, variable-ratio proportioning units originated for first-in-the-field service by Halliburton.
- Diesel-powered pumping units with top hydraulic in-the-well horsepower.

THE CONCLUSION

When formation geology indicates response to fracturing, well-wise oilmen specify Halliburton's Sandoil Fracturing.

Learn more about Sandoil Fracturing. Ask your Halliburton operator for your copy of "Elements of Hydraulic Fracturing". Call the local or district office or write the Halliburton Oil Well Cementing Company, Duncan, Oklahoma.

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251 SERVICE CENTERS—JUST MINUTES AWAY FROM ANY RIG

THERE'S A LUBER-FINER MODEL FOR EVERY TYPE OF ENGINE FOR EVERY TYPE OF OIL!

Model 750-C

Model 200-S

Model 135-S

Model 78

ONLY A GENUINE Luber-finer PLUS A GENUINE LUBER-FINER PACK

CAN GIVE THE EXCLUSIVE PATENTED FILTERING PROCESS THAT HAS MADE LUBER-FINER THE Standard Of The Industry Since 1936

Model 500-C

Models F-155 F-120

Models 272-C 363-C

Models 750-2C 750-3C

MODELS 78, 135-S, 200-S, featuring single-bolt lid, screw-in type pack, and overall compact design for use where space is limited. These Models provide the ultimate in filtration for passenger cars, small trucks and tractors, and other similar engines up to 5-quart, 6-quart, and 7-quart crankcase capacities.

MODELS 272-C and 363-C, featuring the Luber-finer single-bolt lid clamp, O-Ring lid gasket, screw-in type pack, and rugged construction throughout. Designed for heavy-duty service on gas, gasoline or diesel engines up to 3-gallon and 4-gallon crankcase capacities.

MODELS 500-C and 750-C, featuring the Luber-finer single-bolt lid clamp O-Ring lid gasket, large-capacity packs, and extra rugged construction to withstand the most severe service. Designed for use on gas, gasoline or diesel engines up to 5-gallon and 8-gallon crankcase capacities. Also widely used on fuel lines, hydraulic oil systems, and many other industrial applications.

MODELS 750-2C & 750-3C, featuring the Luber-finer single-bolt lid clamp, O-Ring lid gasket, and multiple packs for extra large capacity. Available with either wall or floor mounts for industrial use on engines up to 35-gallon sump, fuel lines up to 15 GPM, hydraulic oil systems up to 450 gals. For larger capacities, two or more Units can be connected in parallel.

MODELS F-120 and F-155, for gasoline and diesel fuel lines on mobile, stationary, or marine applications. Extremely efficient in removing impurities and contaminants from fuel. Single Units will handle flow rates from 0.5 to 1.0 GPM on suction or gravity flow. For larger capacities, connect two or more Units in parallel, or install on pressure-side of fuel pump.

GENUINE LUBER-FINER PACKS available in two types...

DIESELPAK — Expressly designed and recommended for use with all detergent-type compounded oils. Has the abilily to remove the most finely dispersed contaminants without removing or affecting the additives.

REFINING PACK — For use on straight mineral oil, synthetic oils, diesel fuel oil, hydraulic fluids, etc.

★ **THERE IS A GENUINE LUBER-FINER MODEL FOR PASSENGER CARS, TRUCKS, TRACTORS, STATIONARY AND MARINE ENGINES, HYDRAULIC OIL SYSTEMS AND MANY INDUSTRIAL APPLICATIONS.**

WRITE FOR COMPLETE INFORMATION TO DEPT. 8

LUBER-FINER, INC. 2514 S. Grand Ave., Los Angeles 7, Calif

New member Clarence R. Dale of Dale Company (center) being inducted into the Los Angeles chapter of Nomads at the annual business meeting, January 9. To the left is Sergeant at Arms Bill Brooks of Byron Jackson Tools, Inc., and to the right Ritual Master Tom G. Martin of R. J. Eiche & Associates.

Gaylord, Brooks Named Los Angeles Leaders

Robert P. Gaylord, Wagner Morehouse, Inc., is new Nomads president of the Los Angeles chapter for the coming year. William C. Brooks has been elected chapter vice president.

Secretary for 1957 is Tom G. Martin; assistant secretary is Andy Anderson. Treasurer is Ben A. Hilliard and assistant treasurer is W. B. Reinhold. Elected sergeant at arms was Earl M. Daniels and deputy sergeant at arms, Tom R. Ashe.

H. J. Schlarb is senior regent. Harry E. Hester is junior regent.

Houston Group Hears Pacific Northwest Pipeline Head

The regular monthly meeting of the Houston Chapter of Nomads was held at The College Inn on the evening of December 10 with 80 Nomads and guests in attendance.

The foreign guests were: O. B. Rylander, Perforaciones Guarico, C. A., Caracas, Venezuela, and W. O. Calvert, Manufacturers' Representative, London, England.

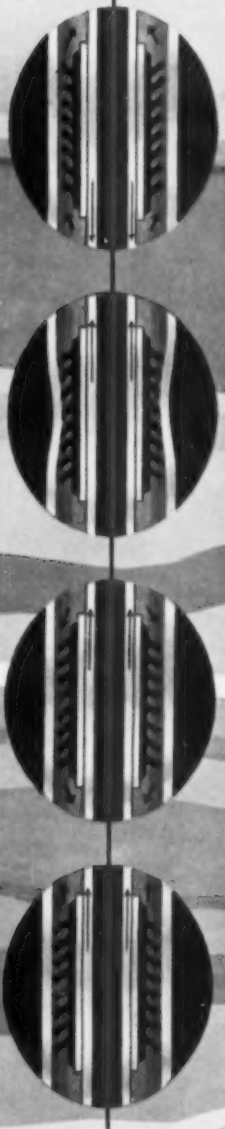
Other guests included: C. R. Williams, Pacific Northwest Pipeline Company, Houston; Ben R. Bourland, Baroid, Houston; John Lloyd, Stanolind Oil & Gas, Houston; Howard B. Book, Reed Roller Bit, Houston; R. J. Haslett, National Tube, Gary, Indiana; C. E. Pendock, National Tube Division, Houston; Joe Baker, Union Oil & Gas of Louisiana, Houston; Hugh Patterson, Phillips Petroleum, Houston; Fred Hodson, oil attorney, Houston; E. E. Childress, Stewart & Stevenson, Houston, and E. D. Carney, Export Tool Company, New York.

C. R. Williams, vice chairman of the board of directors for the Pacific Northwest Pipeline Company, presented a most interesting motion picture on the laying of the 26-in. gas line from San Juan Basin in New Mexico to the state of Washington.

FOUR REASONS WHY

MISSION E-Z SWABS

are fast, safe and economical



1. FREE FALLING

On the down stroke, clearance between fins and pipe allows swab to fall free.

2. PASSES SMOOTHLY THROUGH TIGHT SPOTS

Flexible E-Z Swab Rubber fins allow swab to pass smoothly through tight spots on both up and down strokes.

3. RELEASES OVERLOADS

When load is excessive, fins bend down to bypass excess fluid. This safety relief action prevents overloads and broken wire lines.

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After overload is bypassed, fins spring up until they seal. Wear is slow because fins seal against pipe with light contact pressure.

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MISSION MANUFACTURING CO.

Mission E-Z Tubing and Casing Swabs are made in seven popular sizes (1½", 2", 2½", 3", 4½", 5½", and 7"). They are available through supply stores everywhere. Be sure to get a Mission E-Z Swab before your next swabbing job.

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22-month test showed
substantial savings from using

MISSION MUD MONARCH VALVES

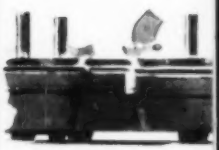
OVER 2400 VALVES AND SEATS were used by a large operator during a 22-month test comparing the cost of Mission Mud Monarch fluid end mud pump valves and seats with the competitive make he was using at the beginning of the test. Due to the size and duration of the test, results may be considered conclusive for the 2500-psi pressures and other conditions encountered.

This test showed that Mission Mud Monarch Valves and Seats cost less than half as much per thousand feet of hole as the competitive make.

Why don't you make a competitive test yourself to find out just *how much* Mud Monarch Valves can save *you?* Many operators have reported important savings at normal pump pressures, even though the advantage of using Mud Monarch Valves becomes greater as pressures become higher. Arrange with your Mission Representative for a competitive test.

COMPETITIVE VALVES

cost more than $36 per thousand feet of hole.



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cost less than $18 per thousand feet of hole!

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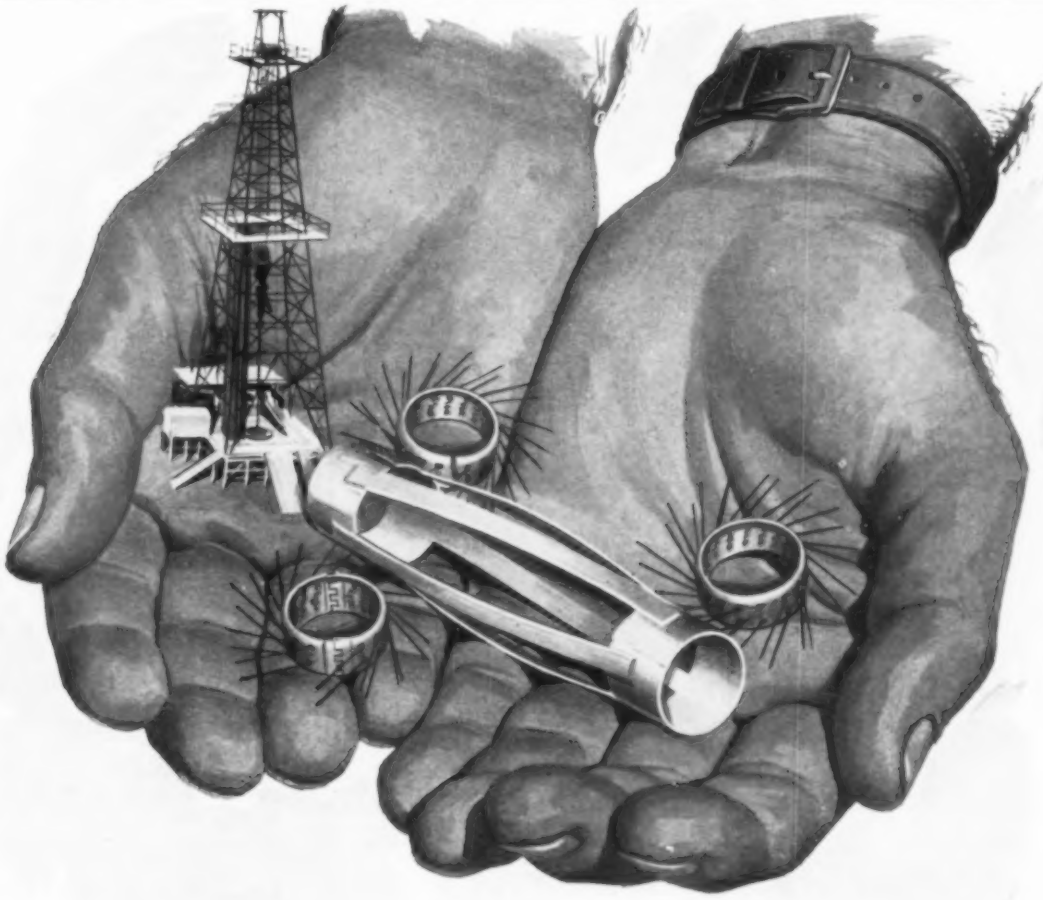
The Oasis

THE WEATHERFORD TECHNIQUE



Your cement job is in good hands

The Weatherford Technique is your best assurance of a good cement job . . . the most advanced method known for the proper conditioning of the hole, preparatory to and during the running and cementing of casing.

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The man from Weatherford: (1) surveys the well condition after the electrical log has been run, (2) recommends the proper type, number and spacing of scratchers and centralizers, (3) supplies and installs the equipment on the casing, (4) recommends the proper make-up of the cement slurry and the optimum running time, (5) expertly supervises the entire program, and (6) prepares a complete well report on the casing and cementing operation.

This Technique is indispensable to safe and economical completions. The man from Weatherford gives the job all he's got. You get a better cement job, more profit and less worry.

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Range of operating depths on gas lift operation is unlimited. **The same valves used at maximum operating depths are used in producing the shallower producing horizons. Stresses and strains on equipment do not increase in proportion to depth, therefore, economics favor gas lift operation as depth of operation increases.**

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Nomads Meeting Dates and Secretaries

New York Chapter, first Monday, of the month, Hotel Roosevelt, New York. Executive Secretary, E. W. Hoeppner, in care of Hughes Tool Co., Room 4414, 30 Rockefeller Plaza, New York 20, N. Y.

Houston Chapter, second Monday. Ye Olde College Inn, Houston, Texas. Executive Secretary, Harry E. Estes, P. O. Box 18161, Houston 23, Texas.

Los Angeles Chapter, second Wednesday, Jonathan Club, Los Angeles, California. Exective Secretary, W. A. Sawdon, P. O. Box 848, Hollywood 28, Calif.

Tulsa Chapter, third Friday, Mayo Hotel. Executive Secretary, E. L. Thomas, P. O. Box 4033, Tulsa, Okla.

Dallas-Fort Worth Chapter, first or second Monday. Secretary, R. B. Gilmore, DeGolyer & MacNaughton, 5625 Daniels, Dallas, Texas.

Houston Nomads Elect 1957 Officer Slate

Tracy T. Word, Jr., Thornhill-Craver Company, was elected to head the Houston Nomads in 1957 at the December 10 meeting of the chapter.

New vice president is E. W. Louden. New secretary is B. W. Pickard; assistant secretary is James B. Hughes. Incoming treasurer is John W. Gates; assistant treasurer is J. V. Spalding. Sergeant at arms is Otis Walker and deputy sergeant at arms is George A. Stout.

Senior regent is W. L. Childs, Jr. and junior regent is W. O. Hedrick. Hedrick was president of the group in 1956.

Tulsa Nomads Fete Officers At Sixth Annual Ball

The Tulsa Chapter of Nomads held its sixth annual inaugural ball January 25 at Stauffers. Formal dinner and inauguration of 1957 officers highlighted the event. Al Donahue's orchestra played for the dance following.

Guy Williams, Dowell, Inc., is the new chapter president, taking the reins of leadership from Don Collins.

New York Picks Delano As 1957 Chapter President

New York Nomads picked 1957 officers at its January 14 meeting in the Hotel Roosevelt.

Elected as president for the coming year is Maurice Delano.

Incoming vice president is E. E. Andreason. Other officers include Hollis Haltom, treasurer; J. E. George, assistant treasurer; Don Kircher, secretary; H. E. Lowrey, assistant secretary; W. E. Volkman, sergeant at arms; J. D. Evans and B. J. Foy, assistant sergeant at arms.

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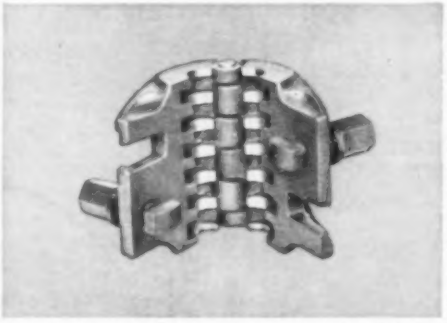

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Technical Correction . . .

Torque Characteristic Curve of Hydraulic Brake Corrected

In the article "New Magnetic Particle Brake," page B-47, January 1957 Issue, Fig. 1 as shown was incorrect. Further investigation showed the correct characteristic torque curve for the hydraulic brake to be as indicated below. The torque of hydraulic brakes used on rigs today continues to increase with speed and is represented by a parabolic curve. To prevent misleading interpretations, it is suggested that this corrected illustration be pasted over that appearing on Page B-47 of the January Issue.

Characteristics of hydraulic brakes are almost identical to those of centrifugal pumps. The horsepower absorbed by the pump or brake is roughly proportional to the cube of the rotor speed. Torque is proportional to the square of the rotor speed. Maximum capacity is determined by either the critical hydraulic speed or critical mechanical speed of the particular design. This latter limitation is dependent on the dynamic balance of the rotor and shaft.

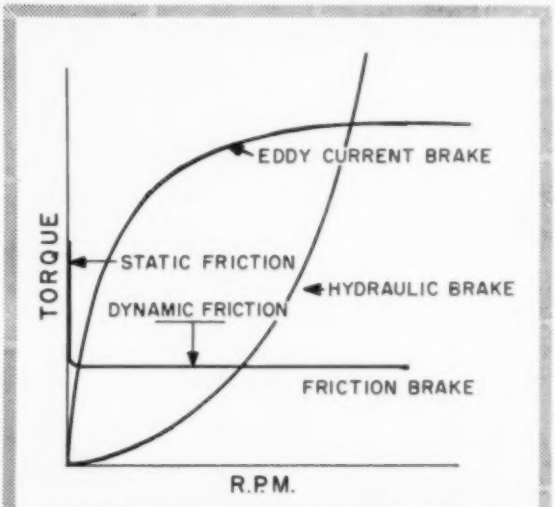

FIG. 1. **Torque characteristics** of typical brake systems used on drawworks today. Static torque of mechanical friction brake is roughly twice the dynamic friction.

If the unit were limited by the critical hydraulic speed, the curve shown in the article would have been essentially correct. Cavitation or flash vaporization of the water in the system would limit torque. However, in the brake designs used today, passages are designed to minimize this effect. The result is that dynamic balance of the moving elements constitutes the limitation in capacity. *This limiting speed is well above the operating drum speeds used today.*

The capacity on all hydraulic units used on drawworks at this time is limited only by rotor speeds which are well above that encountered in practice. The resulting characteristic torque curve is typified by the curve shown in which torque continues to increase with increase in rpm.

James A. LeVelle
Engineering Editor

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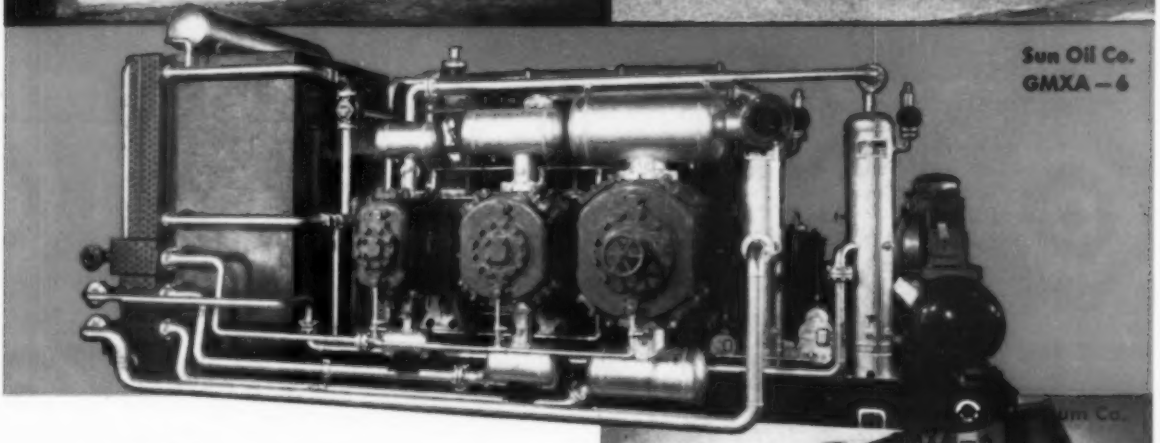

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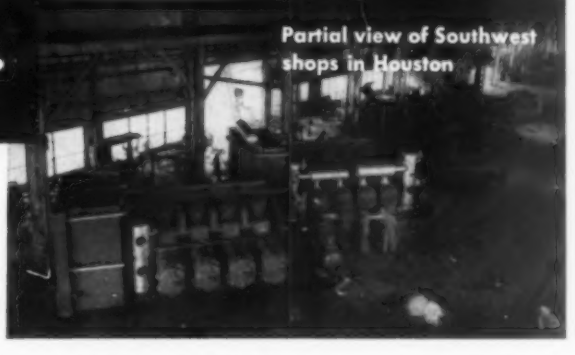

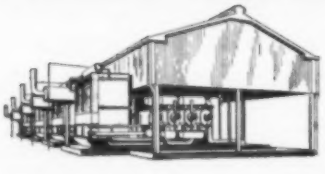

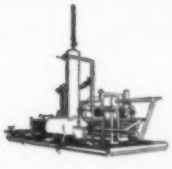

EXPLORATION ACTIVITIES

TEXAS

★ Shell Oil Company has staked a second deep test on its 11,000 acre block on the Javaline Ranch in Hidalgo County, southwest Texas. Test will be No. 2 Boston-Texas Land Trust and is spotted about 3000 ft northwest of the No. 1 well. First well was shut in after gaging 4,000,000 cu ft of gas per day. Phillips Petroleum holds leases on remainder of the 23,000-acre ranch lying in Starr County.

★ Canyon Reef discovery has been gaged in Howard County at the Ashmun & Hilliard Ltd. and U. S. Smelting, Refining & Mining Company No. 1 Grantham et al. The well, 14 miles northwest of Big Spring, flowed 96 bbl of 44.1 deg oil on 24-hour potential test from perforations at 8996-9002 ft.

★ Rank test is being drilled in Hemphill County by Cities Service. Wildcat is scheduled to go to 7700 ft into the Pennsylvanian. Location of the well, on the Humphreys Ranch, is near the Oklahoma border, about 12 miles northeast of Canadian and about 60 miles northeast of Pampa. Cities Service holds a lease block of about 11,600 acres on the ranch.

★ Bill R. Tipton and associates, Marshall, Texas, have completed the No. 1 White as a Pettit zone discovery six miles northwest of Marshall in Harrison County. Discovery flowed 340 bbl of 50 deg oil per day through a 14/64-in. choke from perforations in the Crane section of the Pettit at 6957-66 ft. Gas-oil ratio was 1500 to 1. Operator drilled to a total depth of 7212 ft, cementing 5½-in. casing two feet off bottom. Location is four miles west of nearest gas-condensate producer of the southwest flank of the Woodlawn field. Trice Production and Amerada Petroleum hold interest in the discovery. Lease prices are high and going fast in the area surrounding the Tipton well, drilled on a 22½ acre tract.

★ Texas Tidelands find has been registered by Stanolind Oil & Gas Company. Discovery is the No. 1 Block 84s on the south flank of the McFaddin Beach salt dome off High Island. The well flowed 165 bbl of oil in 12 hours through choke from perforations at 6510-30 ft. An earlier Stanolind just 1000 ft away was completed as a dry hole. Humble Oil & Refining made four unsuccessful trys at production on the north flank of the dome in the late 1930's.

★ Discovery allowable has been requested by C. L. Norsworthy (Dallas) for the No. 2-A Virginia Baker, just east of the Nena Lucia Strawn field, seven miles southwest of Maryneal in Nolan County. Well was completed flowing 723 bbl of oil per day through an 18/64-in. choke from an unidentified section at 6944-74 ft. Gas-oil ratio was 1270 to 1.

★ New Knox County discovery has been made by Fletcher Oil & Gas Drilling Corporation, Dallas. The No. 1 W. L. Moore is the company's first Tannehill sand production in Knox County. The opener is 1½ miles northwest of Goree. Its pumping potential was gaged at 85 bbl per day from 1908-10 ft; gage was at the pump's peak capacity. Well is two miles northwest of production. During drilling phase, the well logged an upper Tannehill sand just below 1800 ft showing better promise on drillstem test than the lower pay. Development is planned for this zone. Fletcher has six other active locations in the county.

★ In Brooks County, South Texas, Associated Oil & Gas Corporation has completed and run an official potential on its J. L. Cage B-5, to extend production in its Cage Ranch field to the south and west. Well is about one mile south of the recently completed Cage C-3 well. Completion of the B-5 was made through perforations at 7156-66 ft in a new sand in the Frio section. On preliminary tests this well flowed at the rate of 1,993,000 cu ft of gas per day plus 72.2 bbl of 63.6 deg condensate, on a 12/64-in. choke with flowing tubing pressure of 2345 psi. Well indicated an absolute open flow potential of 10,000,000 cu ft per day. The new sand and another indicative of production just above established horizons, constitutes the shallowest production discovered in this area to date. Additional development is planned early this year by Associated on its 26,757 acre block, on which it now has eight wells.

★ Additional exploration work is in store for Irion County, West Texas, six miles northwest of Tankersley. Closest production to this rank wildcat, the G. W. Strake (Houston) No. 1 J. C. and M. C. Reed, is in the Arden field, six miles to the northeast. Test is to be a 7600 ft operation, and is staked 660 ft from the north and east lines of section 1-18-H&TC. Lease contains 3200 acres.

WEST VIRGINIA

★ A new natural gas pool has been opened in Randolph County by Columbian Carbon Company at No. 1238-USA, a wildcat in the Dry Creek district. Well tested the Oriskany sand from 5210-326 ft and gaged 582,000 cu ft of gas per day.

★ Rotary Development Corporation has staked a wildcat in Nicholas County to test the Oriskany. This well is the No. 1-A New Gauley Coal Company, located on the Richwood quadrangle.

OKLAHOMA

★ Gulf Oil Corporation swabbed new oil at a high rate from production at a remote wildcat in Woods County. Production at the No. 1 Shade was 39 bbl in eight hours from perforations in the Misener-Hunton at 7182-86 ft. Well is southeast of the Northeast Waynoka pool. Well earlier made 78 bbl of oil and 82 bbl of water on swab from perforations at 7120-28 ft.

★ Olin Oil & Gas Corporation of Tulsa has completed a prolific Gilcrease sand producer as a half-mile southerly step-out to the North Blakely pool in Okfuskee County. Olin's No. 1 Mose Mulley was completed flowing 1176 bbl of oil daily through a ½-in. choke from perforations in the Gilcrease at 2966-74 ft, following fracture treatment. Well made 5 bbl oil per hour natural. After frac, it made 66 bbl an hour through a ¾-in. choke and was finaled flowing 49 bbl an hour through ½-in. choke. Flow pressure was 300 psi, with shutin tubing pressure of 1150 psi.

MONTANA

★ Amerada Petroleum Corporation's No. 1 Tange in Sheridan County has been completed as a major oil producer. This wildcat flowed 800 bbl of 39.9 deg oil in seven hours through a ½-in. choke from a perforated section between 9056 to 9074 ft. This well is about 75 miles northwest of Williston, North Dakota, and 50 miles north of the Poplar field in Montana. Amerada owns a 120,000-acre block in the discovery area.

MICHIGAN

★ Deepest test drilled in the state during 1956, finaled at year's end, has been abandoned. The well is Don Rayburn's No. 1 Watchorn and Wells, in the Watertown township of Tuscola County. Well was drilled at 9128 ft in the dry St. Peter sand. Top of this zone was called at 8898 ft.

KANSAS

★ McCliffe Oil Company has staked its No. 1 Luther, a rank wildcat in Logan County. Well is 28 miles southwest of the Mingo field of Thomas

Comprehensive core analysis data immediately required for drilling and completion operations is best obtained from properly preserved (quick-frozen) samples.

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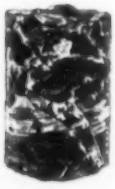

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County. Contract depth is 5400 ft and is located in C NW SW 12-12-37w.

★ Cities Service Oil Company is locating a Granite Wash test on its 4600-acre Densmore block in Norton County. The 3550 ft test is the Archer No. 1, about one mile southwest of Densmore and three miles north and seven miles west of the Ray pool.

★ Skelly Oil Company was last reported drilling ahead below 4850 ft after logging strong oil shows in the Simpson sand at its No. 1 Gish. This apparent oil discovery is three miles northwest of the Runnymede gas field in Harper County.

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GEORGIA

★ A new attempt to find oil in this state is being made by Leighton Drilling Company by redrilling and retesting an old dry hole in Pulaski County. Well is the No. 1 Dana in Land Lot 280, Land District 12, originally drilled to 6035 ft and abandoned. Leighton will clean out and retest at 4950 ft.

LOUISIANA

★ Gulf Oil Corporation has scored an offshore field discovery 29 miles off the coast of LaFourche Parish in 103 ft of water. Well, the Gulf-Humble A-4, produced on initial production test of three hours at the rate of 346 bbl of 30.9 deg oil per day. Flow was through a 10/64-in. choke from perforations at 10,770-85 ft. Gas-oil ratio was 640 to 1. Well is on Block 135, a 5000-acre tract which is 78 percent owned by Gulf and 22 percent owned by Humble.

UTAH

★ Gulf Oil Corporation has completed its No. 1 Desert Creek-Indian, the most westerly producer yet drilled in the Aneth-Desert Creek-Recapture Creek area. A flow of 263 bbl of oil per day through 12/64-in. choke was reported at completion and production is believed to be coming from the Paradox. Perforations are at 5800-10 ft. An earlier test of the same zone flowed 143 bbl of oil in three hours on a ¾-in. choke. This well is 3½ miles southwest of Recapture Creek in San Juan County. No drilling has been done between this well and Recapture Creek, where Shell Oil drilled the discovery well in autumn of 1956.

KENTUCKY

★ Fast pace of wildcatting in the western part of the state has resulted in a good oil discovery in Hopkins County. Pure Oil Company owns the well, the No. 5 Western Kentucky Coal Company. Completion was in the lower O'Hara sand to open the West Madisonville pool. Pure's well went to 2660 ft, cementing 5-in. casing on bottom. It flowed 187 bbl of oil in 24 hours after being acidized. Flow was through perforations at 2480-90 ft.

NEBRASKA

★ Shell Oil Company has placed on pump its No. 1 Darnall, Banner County discovery in the J sand. This marks the third discovery for Shell in the past two or three months in the Nebraska Panhandle. The Darnall well pumped 202 bbl of oil a day on test at 5153-72 ft. New pool is 1½ miles southwest of the Mosier field.

NEW MEXICO

★ Lone Star Producing Company, Dallas, Texas, has completed its No. 1 Santa Fe, Lea County, as a Siluro-Devonian discovery. Well potentialed 541.48 bbl of 44.6 deg oil, with no water, flowing through 11/64-in. choke from perforations at 12,173-83 ft. Flowing tubing pressure was 640 psi. Lone Star cemented 5½-in. casing on bottom at 12,188 ft. Wildcat is 20 miles north of Tatum and two miles north of production in the Crossroads field.

★ First new pool in the state for 1957 is being completed by Shell Oil Company, 16 miles southwest of Hobbs in Lea County. Wildcat is the No. 1 Allen Estate, 1½ miles southwest of Pearl. On a 150-min drillstem test of the Queen sand at 4705-800 ft, recovery was 35 ft of slightly gas-cut mud, 30 ft of mud-cut oil, estimated to 70 percent oil, 30 ft of oil and gas-cut mud, estimated to be 10 percent oil. On retest at 4703-900 ft, gas surfaced in 6¾ hours and tool was pulled after being left open eight hours. Shell is completing the well now.

Los Angeles Harbor Rights To Standard Oil

Standard Oil Company and four affiliates have been granted offshore drilling rights in the inner harbor of the Port of Los Angeles.

The port's Board of Harbor Commissioners announced an agreement under which Standard will lease 1350 acres in the port's inner harbor for 20 years. The oil company will "pay the Board of Harbor Commissioners the sum of $100,000 as a cash bonus, whether oil is found or not, and $20,000 annually" for five years.

According to the board's announcement, made by Lloyd Menveg, president: "The annual payments of $20,000, in addition to the $100,000 cash bonus, will be paid in advance, to be credited against royalties paid each succeeding year should oil be found.

"In the event of oil discovery, Standard and its associates will pay royalties of 30 percent on less than 100 bbl per day. This rate will increase on a sliding scale up to 50 percent on 250 bbl per well per day."

Menveg said that there are already several wells in operation on the 1350-acre tract, but they are located exclusively in the southern area.

Originally, four independent oil companies and Standard Oil had filed separate applications for offshore drilling rights in Los Angeles, but they amalgamated with Standard in a single proposal covering oil and gas leases and royalties to be paid the Harbor Department in the event oil is found.

The four firms teaming with Standard are G. E. Kadane & Sons, Frank J. Waters, James J. Arditto and Noah Dietrich.

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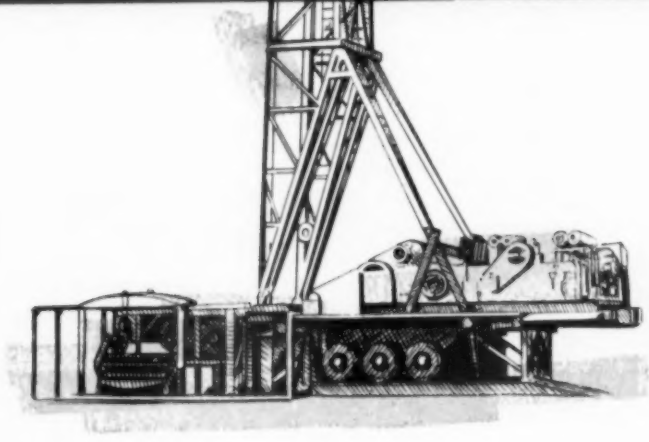

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What's doing in DRILLING

★ **East Texas drilling** in 1956 was far ahead of post World War II averages. About 1200 wells were drilled, 424 of which were classified as wildcats. Sixteen new oil pool finds were made; 10 new oil pays in established areas were made. Only three new gas fields were discovered. Four oil field and one gas field extensions were made. Anderson and Wood counties scored the most successes.

★ **Mesa Drilling Company,** subsidiary of Camay Drilling Company of Compton, California, is now operating under the name of Camay Drilling Company, Rocky Mountain division. Offices will continue to be in Denver, with no change of management or personnel. M. D. McBride is division manager and F. B. "Buster" Link is division drilling superintendent.

★ **More Oklahoma deep drilling** may be expected this year — if all deep tests pay off as British-American Oil Company's No. 2 Harrison, the state's deepest well. The laterally-drilled, 15,310 ft deep test, drilled last year, was a discovery on the old Knox structure in Grady County. Since its completion 10 months ago it has produced 250,000 bbl of condensate and two billion cubic feet of natural gas.

★ **24 of 26 wells** drilled by Warren-Bradshaw Exploration Company, Tulsa, Oklahoma, in 1956 were completed as producers. The wells are in Oklahoma, Texas, and New Mexico. The 92 percent success ratio included all wildcat, stepout and field wells.

★ **Two new Cuban wells** are underway by Cuban Stanolind Oil Company. Drilling for this firm began with the No. 1 Los Chivos, four miles north of Alto Songe in Oriente province. Second Cuban Stanolind test has been spotted on the Sierra de Canasta in the Guantanamo area. These wells are being drilled as part of an exploration program on some 15,000,000 acres on the island and offshore areas of Cuba.

★ **Two large rigs** running in Egypt's Sinai Peninsula, owned by Camdrill International, a Southern California Petroleum Corporation subsidiary, are being sold to International Egyptian Oil Company for $1,100,000. Camdrill operated the rigs for International Egyptian from February, 1956, until the Israeli invasion of Egypt stopped operations. Officials of the firm, looking back over the Egyptian work in the past year, termed the operations "profitable." Camdrill, which operates one rig in Sicily, is now seeking other drilling contracts in the Mediterranean.

★ **Shell Oil Company** may give up its Persian Gulf exploration operations as a result of the loss of a large offshore drilling rig near the island of Bahrein. On January 2 a sudden storm wrecked the $1,500,000 platform and left 20 Arab workers dead or missing. The rig was being moved to a location in deeper water when overtaken by the storm. Shell had invested $25,000,000 in Persian Gulf oil explorations over a period of several years.

★ **Delta Drilling Company,** Tyler, Texas, has merged its three subsidiary companies into Delta proper to simplify its corporate organization and operation, says Joe Zeppa, Delta president. Merged were Delta Gulf Drilling Company, Creek Oil Company, and Algord Oil Company. Also merged were Delta's two Venezuelan subsidiaries, Perforaciones Guarico, C. A., and Perforaciones Delta, C. A., under the name of the latter firm. Delta Marine Drilling Company, New Orleans, Louisiana, will handle the firm's offshore work. Delta also is active in European and Near East drilling activity through its subsidiary in Rome, Italy, Compagnia Industrie Metanifere Affini.

★ **Pease Drilling Company** has been organized at Grand Junction, Colorado, by W. H. Pease. Pease was formerly with Mesa Drilling Company.

★ **Late 1957 spudding date** has been set for drilling of an initial well in Syria by The German Petroleum Company, Deutsche Erdoel Aktiengesellschaft. The company was granted a 15,000 square kilometer drilling concession before the Middle East crisis erupted. Offices have been set up by the company in Damascus.

★ **Egyptian drilling** operations are being resumed by Sahara Petroleum Company, a Continental Oil Company subsidiary. Prior to halting operations due to the Suez crisis, Sahara Petroleum had three wells drilling in the Western Desert, one near Mersa Mathur, about midway between the Libya border and Alexandria, and two in a western concession, bordering Libya. Sahara is operating firm for the 90,000 square mile concession of Continental, Cities Service, Ohio oil companies and Richfield Oil Corporation. Ten Americans are being permitted by the Egyptian government to re-enter the country to resume operations. About 60 employees and their families left Egypt at the outbreak of the Canal crisis in October.

★ **Contract drilling in foreign countries** is to be expanded by Drilling and Exploration Company, Inc., through its several subsidiary firms. With rigs now operating in Brazil, Oman, Iran, Turkey, Holland, France, Sicily, Nigeria, and the U. S., the company plans to position additional rigs around the world. Another rig is to be moved into Turkey shortly, negotiations are being completed for a rig to enter Pakistan, and additional rigs may be needed in Iran as a result of a recent major discovery. In Brazil, the company's labor-management contract already covers 20 rigs. In the U. S. Drilexco operates 18 rigs and is contemplating entering the offshore drilling field.

★ **Brewster-Bartle Offshore Company** has been organized by Brewster-Bartle Drilling Company and Kerr-McGee Oil Industries, Inc. The new company will engage in drilling in the Gulf area on a contract basis to any operator — not just Kerr-McGee, says John Domercq, Jr., executive vice president of the drilling company and president of the new offshore drilling concern. Brewster-Bartle Offshore is expected to get in the water this fall with a $3,000,000 rig similar to Kerr-McGee's new Rig 46. To repay indebtedness incurred from the purchase of offshore drilling equipment, Brewster-Bartle has filed SEC statements calling for $2,000,000 of 5 percent debentures and 100,000 shares of $2 par common stock.

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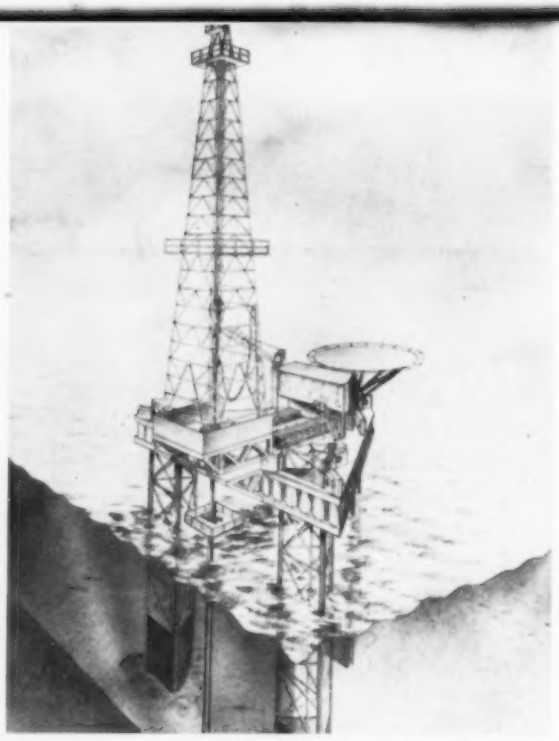
★ **Twelfth Drilling Safety Clinic,** sponsored by the American Association of Oilwell Drilling Contractors, will be held May 23-24 at the Baker Hotel in Dallas. W. E. Armentrout, Southeastern Drilling Corporation, Dallas, chairman of the program committee, said the dates for this year's clinic are being advanced to avoid time conflict with fall oil industry meetings. The 1956 clinic was held in November. Plans for the clinic were made at a meeting of the AAODC Safety Committee in Dallas, January 9. Committee Chairman Donald J. Gillespie, Glenn Gillespie & Sons, Cushing, Oklahoma, announced that a permanent safety publicity subcommittee was named, to be led by Mark Johnson, Employers Mutual Liability Insurance Company of Wisconsin, Dallas.

★ **Assets of Prince Drilling Company,** Houston, Texas, drilling contracting firm, have been purchased by a newly-organized company, Prince Marine Drilling and Exploration Company. Z. C. Ambrose, president of the new firm, indicated that Prince Marine would continue in the oil well drilling business substantially as did the predecessor company, with no significant changes in personnel anticipated. At the same time it was announced that Dewey K. Davis, formerly drilling superintendent for Penrod Drilling Company, had resigned to join Prince Marine. Davis, who had been with Penrod since 1933, will direct operational activities of Prince Marine. Equipment acquired by Prince Marine in the purchase includes two submersible inland drilling barges of about 16,000-ft capacity and two land rigs of about 12,500-ft capacity, plus miscellaneous boats, gear and automobiles. The new company also acquired from the Prince Interests some producing acreage involving three oil wells and 13 gas wells in six Texas fields. Officers of Prince Marine Drilling & Exploration Company include Z. C. Ambrose, president; Dewey K. Davis, vice president and general superintendent; and James B. Griffin, secretary and treasurer.



Workover, drilling, completion platform being built for Deepwater Exploration Company, Houston. Price of the combination-type platform, complete, is said to be $1,500,000. Unit may be lowered to the water, floated to a new work location, then raised again on electrically powered legs — all within a few hours. Platform can operate in water to 70 ft, using equipment rated for 10,000 ft drilling. Completion of Deepwater's new unit has been set for June, with construction at R. G. LeTourneau's Vicksburg, Mississippi, plant.

Rotary Rigs Operating in Oil Fields of United States and Canada*

	Dec. 17	Dec. 24	Dec. 31	Jan. 7
Alabama	9	8	8	8
Arkansas	23	23	20	21
Arizona	0	0	0	0
California	111	109	111	107
Colorado	68	56	49	42
Florida	2	2	2	2
Georgia	0	0	0	0
Idaho	0	1	1	1
Illinois	82	62	55	47
Indiana	16	13	9	6
Iowa	1	1	1	1
Kansas	190	177	177	157
Kentucky	11	12	16	10
North Louisiana	79	49	41	42
South Louisiana — land	322	321	308	294
South Louisiana — offshore	100	103	104	102
Total Louisiana	501	473	453	438
Maryland	0	0	0	1
Michigan	16	13	13	11
Missouri	0	0	0	0
Montana	34	32	28	22
Mississippi	31	24	24	24
Nebraska	29	32	29	25
Nevada	2	2	2	2
New Mexico	151	143	128	119
New York	0	0	0	0
North Carolina	0	0	0	0
North Dakota	28	28	26	28
Ohio	0	0	0	0
Oklahoma	298	271	266	253
Oregon	0	0	0	0
Pennsylvania	8	9	7	10
South Dakota	2	1	1	2
Tennessee	0	0	0	0
Texas Gulf Coast-land	282	291	244	237
Texas Gulf Coast — offshore	8	6	8	6
West Texas	415	381	370	352
North Texas	401	358	344	314
East Texas	77	77	64	65
Total Texas	1183	1113	1030	974
Utah	30	28	28	30
Washington	1	1	2	1
West Virginia	2	2	2	2
Wyoming	65	60	61	51
United States	2894	2696	2549	2395
Western Canada	238	234	210	222
Grand Total	3132	2930	2759	2617

As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company.

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WHEN PUMPS ARE RUNNING
NEW MODEL RUMBA
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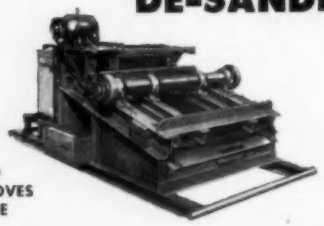

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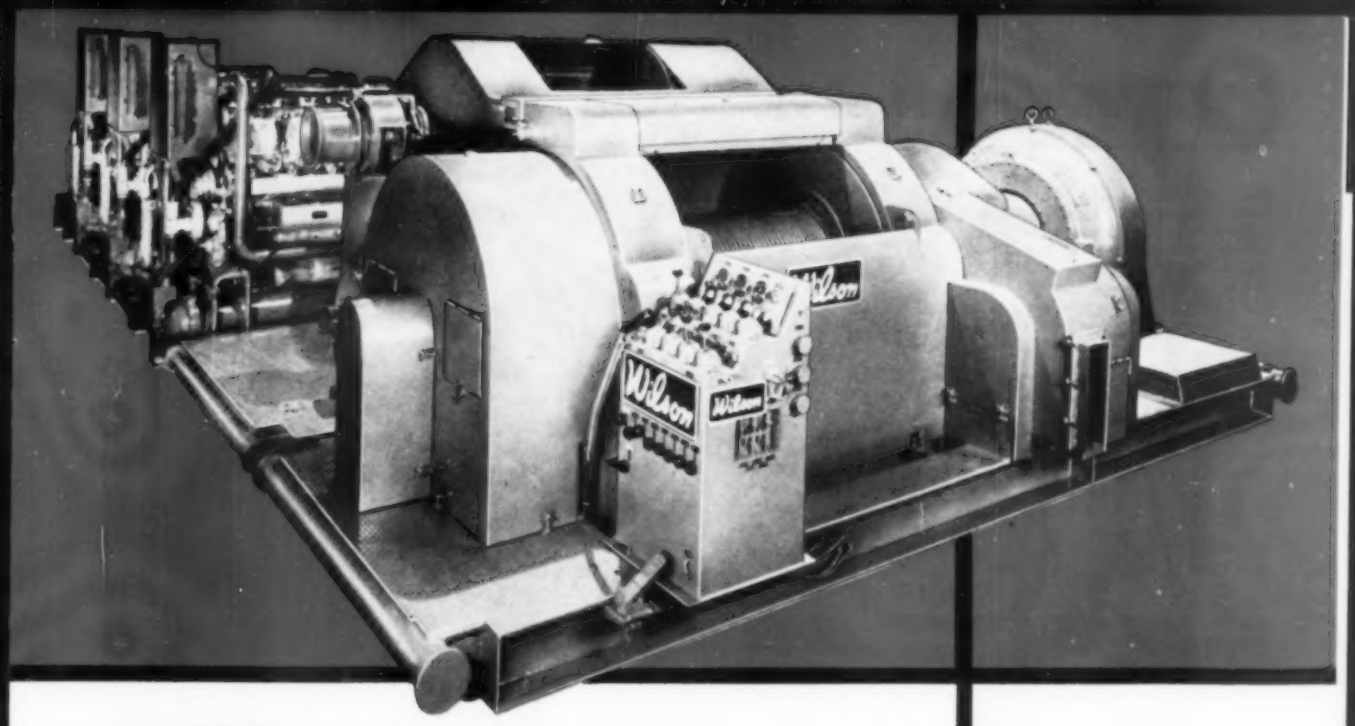

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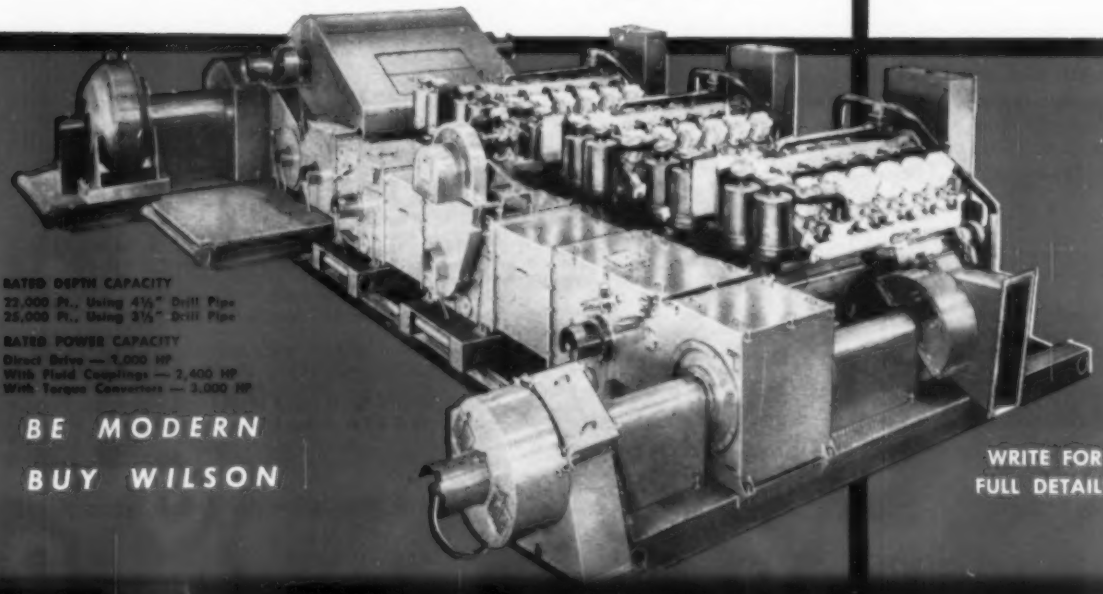

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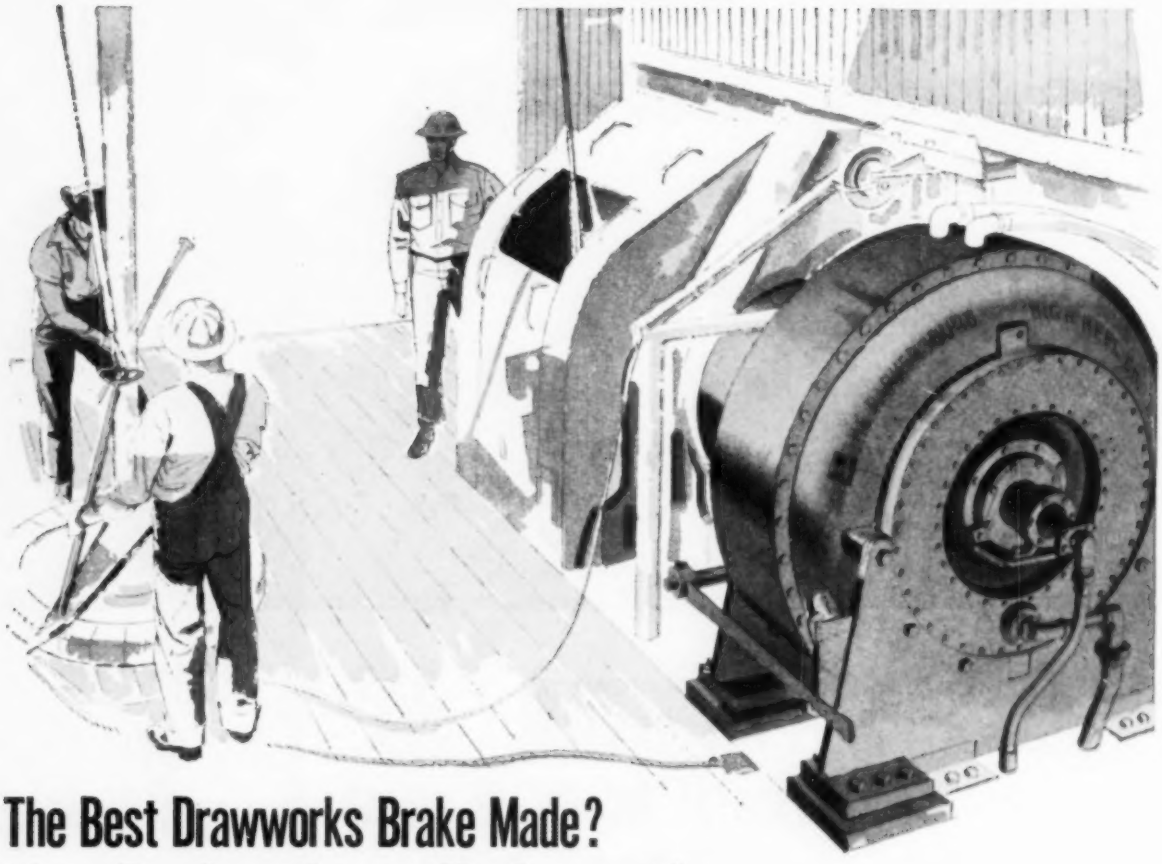

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RUNNING TOUR with MEN in the INDUSTRY

Alexander J. Manulik has been named district geologist in West Texas, with headquarters in Midland, for Monterey Oil Company. He was formerly employed by Continental Oil Company. Also announced, **John O. Davis** to Midland, Texas, production superintendent of the West Texas district. Davis was formerly over South Texas operations.

A. J. Manulik

L. J. Taylor

Lloyd J. Taylor, a veteran of 16 years in petroleum industry land work, has joined Trunkline Gas Company of Houston, Texas, as superintendent of the land department for production activities. Prior to joining Trunkline Gas, Taylor was district manager for Midstates Oil Corporation.

Continental Oil Company's headquarters production department has announced the appointment of two key men. **F. B. Willson,** Houston, Texas, former southern region superintendent of natural gas and gasoline operations, promoted to the newly created position of coordinator of Conoco's natural gas sales. **A. E. Crouse,** Fort Worth, Texas, appointed to the newly created position of coordinator of plant operations, headquarters production department. He formerly was southwestern region superintendent of natural gas and gasoline operations at Fort Worth.

Producing department headquarters, Magnolia Petroleum Company, for the Lea district will be established in Hobbs, New Mexico. **W. C. Dougherty** will be district superintendent and **J. M. McLauchlin** will take over Dougherty's duties as management assistant, employee relations in the Dallas office. **Charles T. Evans,** petroleum engineer in the Kermit, Texas, district, will be promoted to district petroleum engineer in charge of the new Lea district in Hobbs. **Thomas R. Perfect,** chief clerk in the Kermit district, has been transferred to the Lea district and **E. Jack Kennon** will take his place at Kermit.

Hugh D. Clark, chief clerk at the Vanderbilt producine district, has transferred to the Luling district replacing **H. A. Pressler,** who is retiring. **Ernest H. Murphy** is chief clerk at Vanderbilt.

Cities Service Oil Company reorganized its West Texas area into two districts. All properties north of Odessa, Texas, are to be consolidated into the North Odessa district, with **A. P. Coe** of Pampa, Texas, named to the post of district superintendent. **K. D. VanHorn** of Odessa is the district eneineer and **C. T. Kemerling** is district clerk.

E. L. Cralle is superintendent of the new South Odessa district, assisted by **O. B. Seay** as district engineer and **W. E. Stancoff** as district clerk. **D. L. Kastner** of Odessa is assistant division superintendent for West Texas production operations. **R. E. Groves** of Odessa has been promoted to division clerk and will supervise clerical work of both West Texas districts. The entire West Texas area is under the supervision of **D. D. Bodie** of Hobbs, New Mexico, division superintendent of all the company's West Texas-New Mexico production operations.

William W. Clawson, former Magnolia Petroleum Company geologist, has been named coordinator of domestic production and a member of the producing committee of Socony Mobil Oil Company, Inc., in New York City. Since 1952, Clawson has served as president of Mobil Producing Company and Mobil Oil of Canada, Ltd. Both are exploration and producing affiliates of Socony Mobil. Succeeding him as president in the two posts at Mobil producing headquarters in Billings, Montana, will be **Edward C. Cram,** presently coordinator of domestic production.

Bruce E. Roll has been appointed production superintendent of the Kansas production district of Lion Oil Company, a division of Monsanto Chemical Company. Roll, who has been stationed in Bismarck, North Dakota, as production superintendent of the company's Bismarck district is being transferred to Pratt, Kansas.

Officers of Standard Oil Company of California, Western Operations, Inc., have been announced. Named directors and vice presidents were **F. C. Loomis,** (supply and transportation), **O. N. Miller** (manufacturing), **J. E. Toussaint** (producing) and **H. G. Vesper** (marketing). Miller, Toussaint and Vesper have previously served as vice presidents of the parent corporation.

Dr. John Whitaker, geologist, has been named eastern representative for Hycon Aerial Surveys, Inc. He will be located in New York City, in the offices of Fisher, Neblett & Company, Inc.

Two personnel changes have been announced by the Independent Petroleum Association of America. **Richard D. Lambert** of Tulsa, Oklahoma, who has been associate editor of IPAA's magazine, the Independent Petroleum Monthly, is being transferred to Washington as assistant director of information, and **Gene R. Sherrod** of Houston, Texas, has joined IPAA as district representative.

Appointments of **Frank Siegel** as division manager of exploration, **Hilton Westmore** as division chief geologist, and **A. Douglas Brown** as division petroleum engineer for Sun Oil Company's Canadian production division have been announced.

J. Patrick D'Artois has been appointed resident manager in charge of all operations of the Ohio Oil Company of Guatemala, a subsidiary of the Ohio Oil Company. **A. H. Petsch** has been appointed exploration manager of the organization. **E. A. Graham** has been named controller.

Henry L. Waszkowski, assistant to the coordinator of domestic production, Socony Mobil Company, has been named assistant to the manager of the company's producing department. For a time during the Korean war he was assistant director of the production division of the Petroleum Administration for Defense, in Washington.

T. E. Weirich, formerly chief subsurface geologist for Phillips Petroleum Company's land and geological department, has been named assistant manager of the department's Osage area, Osage County, Oklahoma, and **Renato Passega,** exploration research geologist, has assumed the duties formerly handled by Weirich. Both are headquartered in the Bartlesville, Oklahoma, offices.

R. B. Stewart has been promoted to manager of Phillips Petroleum Company's natural gas department. He succeeds A. M. Rippel, who died December 12 in the crash of a company plane near Bartlesville, Oklahoma. **Dan L. Mayer,** formerly general superintendent of the department, has been advanced to replace Stewart as assistant manager.

Also announced was appointment of **M. H. Cullender,** previously gas sales representative at Amarillo, Texas, as director of the department's engineering division. The former coordination and gas settlements divisions have been consolidated into a services division with **C. T. Dickerson** as director. **W. L. Cox** succeeds Cullender as Amarillo representative.

J. J. Hohler has been named division exploration manager of Shell Oil Company's newly created marine exploration division headquartered in Houston, Texas. **P. L. Terrasson** has been named division geophysicist for the new marine group.

John V. Boyce, of Houston, Texas, has been elected president and a director of Texas Calgary Company, Abilene, Texas. He assumes the position formerly held by **Ray McGlothlin, Sr.,** of Abilene, who has been elected to the newly created office of executive vice president. Boyce is the former president of Panhandle Oil Corporation.

Walter Speckhard, geophysicist for the company's central division was transferred from Oklahoma City, Oklahoma, to the Dallas, Texas, head offices and promoted to area geophysicist. This will include Kansas, Nebraska, Oklahoma, and the Rocky Mountain states.

Russell W. Anderson has been named manager of the newly formed industrial engineering department of Geophysical Service, Inc.

William B. Barry has been appointed chief petroleum engineer of H. Zinder & Associates, Inc. Prior to joining Zinder, he served with the Phillips Petroleum Company.

W. B. Barry

R. C. Brown

R. C. Brown, president, Hudson's Bay Oil and Gas Company, Ltd., has been elected chairman of the board of governors of the Canadian Petroleum Association. He succeeds **G. L. Knox,** president of the California Company.

Dr. Mohamed Mortada, senior engineer at Magnolia Petroleum Company's field research laboratory near Dallas, Texas, has been named winner of the two highest awards a young engineer can receive from the AIME and the Founder Societies. The Alfred Noble Prize and the Institute's Rossiter W. Raymond Award went to Dr. Mortada for his outstanding paper describing better oil production cost control and improved oil recovery and valuation.

Lauren G. Morris, Billings, Montana, and **Glenn E. Blackledge,** Mexico City, Mexico, have been promoted to managers, the Canadian seismic division and manager of the logging division, respectively, of Seismograph Service Corporation. Morris formerly served as a party supervisor and Blackledge assistant manager.

Dr. Enrique T. Mauri, exploration manager for YPFB of Bolivia, South America, has opened consulting offices in La Paz, Bolivia. For the past four years Mauri has been with YPFB, the Bolivian Government Oil Company, where he was chief geologist from 1952 to 1954 and exploration manager from 1954 until his leaving in November, 1956. Prior to that he had worked for YPF in Argentina.

Wilbur Rocchio and **A. N. (Neil) Brown** of McRae Oil & Gas Corporation have been promoted.

Rocchio is executive vice president of McRae Oil & Gas and president of its wholly owned subsidiary, Roden & McRae Drilling Corporation. Previously he had been vice president of both concerns. The

Wilbur Rocchio

A. N. Brown

position of executive vice president of the parent concern is a new one in the organization. In taking over as president of the drilling corporation, Rocchio succeeds **James A. McRae,** who moved up to chairman of the board.

Brown, manager of the land department of McRae Oil & Gas, has been elected a vice president of the concern. He will continue in charge of the land department.

Four promotions involving Mt. Vernon production district employees of Ohio Fuel Gas Company have been announced. **Frank McCament,** Mt. Vernon, Ohio, has been promoted to Mt. Vernon district production superintendent, **succeeding H. C. (Pat) Dean,** who has retired. **Alva M. Petty,** Mt. Vernon, has replaced McCament as district foreman. **Cecil L. Dailey,** Mt. Vernon, has been named construction foreman, replacing Petty. **Clyde E. Sunkle,** Granville, has been promoted to Dailey's former job as well as foreman at Knox Storage.

Two promotions involving employees in the Ohio Fuel's northern production district also were announced. **Curtis S. Piper,** Wooster, has been promoted to district foreman, succeeding **Emmet A. Green,** who has retired. **Gerald D. Laidley,** Wooster, has been promoted to construction foreman, replacing Piper. **Herman W. Becker,** 65, Sugar Grove, Ohio, has retired after 32 years of service with the Ohio Fuel.

Jack L. Hollis, chief geophysicist for British-American Oil Producing Company, has been appointed to the newly created position of exploration coordinator. Formerly he was with Seismograph Service Corporation.

Sherman L. Vencil was made area geophysicist of the company's southern and southwestern divisions comprising Texas, Louisiana, Mississippi, and southern New Mexico. He joined British-American in 1952.

Henry E. Winter has joined the executive offices of International Petroleum Company, Ltd., in Coral Gables, Florida, as Venezuelan coordinator. Winter transferred to International Petroleum from the producing coordination department of Standard Oil Company (New Jersey) where he was regional executive for South American producing.

Eugene E. Kincaid, reservoir engineer for the Murphy Corporation, has been promoted to division engineer with headquarters in the Shreveport, Louisiana, division office. He joined Murphy Corporation in 1955, and was formerly with Carter Oil Company.

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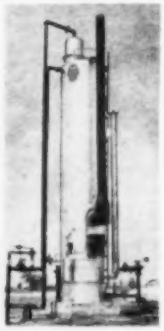

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Performance Report

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BIT DATA:

Description—Double Cone Drilling Bit
Size—6⅜"
Carat Weight—350.10 cts.
Net Bit Cost—$786.45
Diamonds—Large

Photo shows appearance of bit on return for salvage.

Location:

Candelaria Field, Kennedy County, Texas.

Formation:

Vicksburg

Performance:

In hard shale and sandstone of the Tertiary Period known as the Vicksburg Formation, this bit cut a total of 1404 feet in 220 hours. Run from 12,096 feet to 13,500 feet, this bit did the work of approximately 18 conventional bits. It saved the operator 18 round trips of at least 8 hours each, or SIX FULL DAYS. The average penetration rate was 6.38 feet per hour. Estimated cost per foot of conventional bits, up to $1.82. This diamond drilling bit was in excellent condition after use and gave over 80% diamond recovery for a cost per foot of only $0.56.

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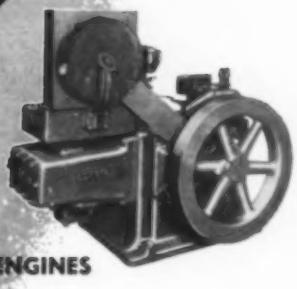

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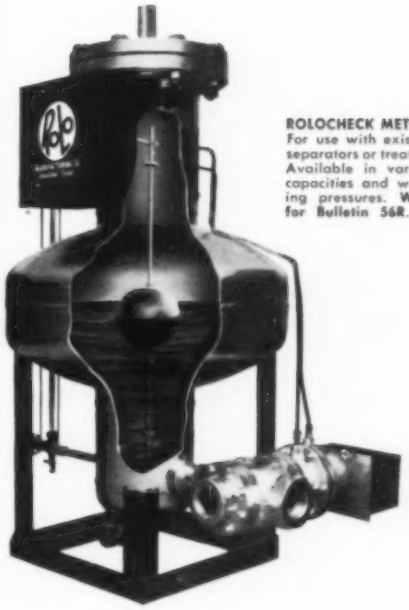
ROLOCHECK Meters measure oil by alternately filling with and discharging exactly calibrated volumes of oil. Each cycle is counted on a new, rugged counter. ROLOCHECK Meters are designed for oil field use; **proven** in oil field service . . . no gadgets, no unnecessarily complicated controls to fail in unattended operations.



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(2) **No slippage.** The new Rolo Neutral-Position 3-Way Valve is of a special design which eliminates the possibility of both inlet and outlet ports being open at once when the valve is switching ports. **Oil cannot bypass the meter.**

(3) **Minimum maintenance.** Only internals are a float and a float guide rod. Valve has sturdy rubber-to-metal inner valves. Sand and other sediments are no problem.

Also:

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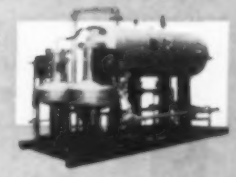

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Midland, Corpus Christi, Kilgore, Wichita Falls, New Orleans, San Pedro, Bakersfield, Ventura, Casper, Tulsa, Mt. Vernon, Edmonton (Alta.), Venezuela: Peticon.

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ROLO MANUFACTURING COMPANY

P. O. Box 6763, Houston 5, Texas

Please send me the following:

Bulletin 56R ☐ Bulletin 56MS ☐ Catalog 56W ☐

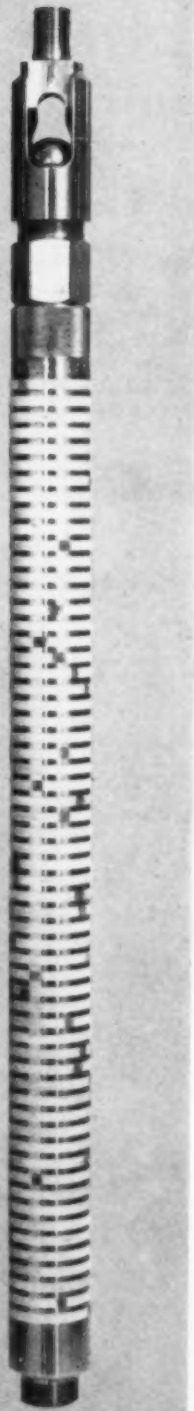
NAME_____

COMPANY_____

ADDRESS_____

Metal to Metal Wear...

is the real villain in sucker rod pump troubles. It accounts for most of your repair and pump pulling expense.



The Martin Idea...

for getting away from this trouble has always been to make use of the best available materials — *Natural Rubber* for the key material in plunger rings; *Synthetic Rubber* for the key material in resilient ball guides for cages.

The accurately grooved and drilled metal body of **The Martin Plunger** does not touch the barrel. Only the resilient rubber and duck rings contact the barrel. This material — with its great natural resistance to abrasion as well as its slipperyness-when-wet — has a much slower wearing action on the barrel. Most often your barrel will not need replacing. These rings have an amazing ability to take the kind of abuse that goes with oil well pumping, and this means longer runs. Plunger cost is reduced because replacing the rings costs only about one fourth as much as a new plunger, and this saving is, of course, added to the barrel saving and longer runs.

Patent No. 2,591,174

The Martin Rubber Guide Cage protects the ball from all metal contact except when it rests upon its seat. The ball is protected to such an extent that ball and seat life is usually doubled. The synthetic ball guide and stop cannot beat out because of its resilience. Its life is therefore much greater than any metal and you get this longer cage life in addition to better ball and seat life. The two guides are easily replaced when the occasion does arise.

No real capital outlay is required to get these benefits because the cost of Martin Plungers and Martin Cages is very much the same as you are now spending for replacements — sometimes less.

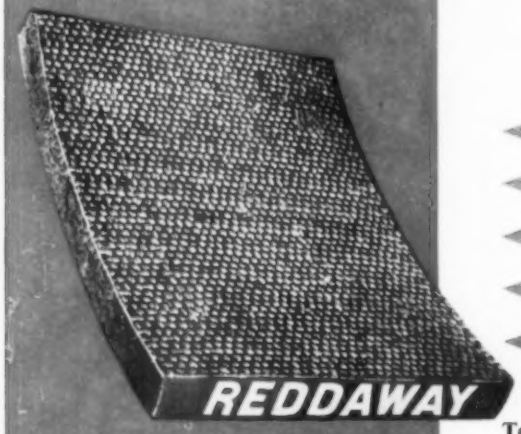
All regular or stroke-thru ROD PUMPS and TUBING PUMPS can be equipped with Martin Plungers. Martin Rubber Guide Cages are made in all sizes and styles. Write for our catalog No. 4; also see Composite catalog for 1956-57.

JOHN N. MARTIN

Manufacturer

9 W. BRADY • TULSA, OKLA.

LUCEY Export



REDDAWAY

OIL FIELD

Brake Blocks

Give you

- smoother, safer feed-off
- longer drilling life
- less wear on brake flanges
- faster installation time
- greater operating economy

Top quality Reddaway Oil Field Brake Blocks and Linings—metallic or non-metallic—are the choice of experienced drillers all over the world . . . because they provide the greatest combination of values of any comparable product! Smoother, more uniform friction always guarantees even, *safer* feed-off at all times under operator's direct control . . . *allowing more hole drilled per brake horsepower.* Reddaway brake blocks and linings *last longer* . . . put *less wear* and tear on your brake flanges . . . and *stay tight* because their bolt holes are doubly reinforced. Accurate sizing and drilling to close tolerances insure *faster installation, too!* For real operating economy over all types of drilling conditions, join the drillers who *know* . . . order Reddaway Brake Blocks from Lucey Export for your next job.

Reddaway "QUICK CHANGE" Rotary Blocks Also Available—Now you can bolt on Reddaway's rugged rotary blocks from the outside without removing the brake band! Crewman simply slides replacement block between band and drum and tightens bolts from the outside of the band. Drum is ready for operation in *70 per cent less time.* Special "SHAKE PROOF" nuts are firmly embedded in the block. The Reddaway is the only *bolt-on* type block that can be installed without removing the band. The brake bands therefore *cannot spring out of shape.* Either "Standard" or "Quick Change"—REDDAWAY BRAKE BLOCKS serve you BETTER!

Here's why

REDDAWAY MEANS BETTER BRAKE LININGS

Minimum cotton in asbestos cords eliminates carbonizing and glazing that cause erratic friction and lining failure.

Deep-penetration curing and impregnating in vacuum autoclaves produce a denser, more uniform brake block that resists heat, moisture, and oil . . . without excess volatiles that cause unpleasant odors.

Quality-control engineering gives precise degree of density and firmness to prevent grabbing and slipping. Standing and running friction are virtually identical, providing perfectly controlled braking on even the heaviest pipe.

Controlled hardness keeps metal splinters from imbedding in the lining . . . prevents major cause of brake flange scoring.

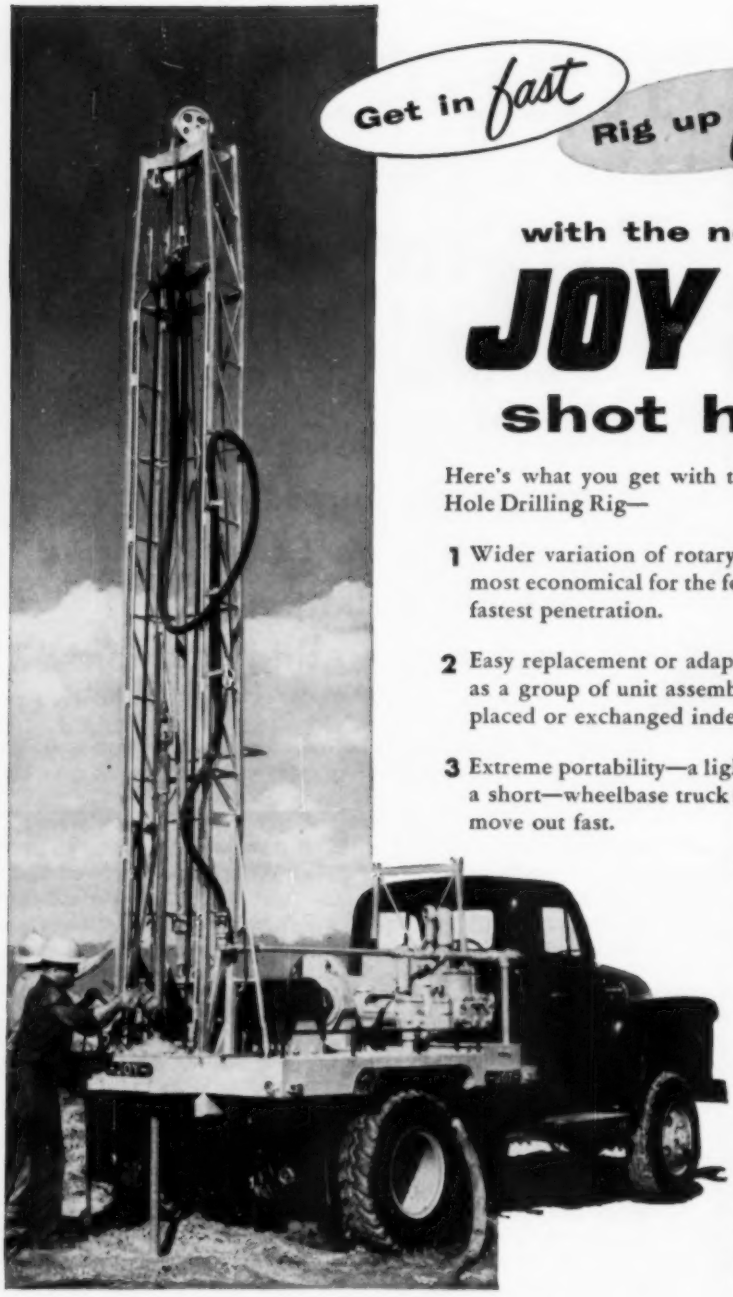
Scientifically designed brass ferrules and brass reinforcing wires assure double protection against loosening of Reddaway Brake Blocks in service.

Uniform construction, designed and drilled exactly to specifications . . . a size to fit every popular rig in current use.

Exclusive Exporters of Reddaway Brake Blocks

LUCEY Export

233 BROADWAY, NEW YORK 7, N. Y.



Get in *fast* Rig up *fast* Get out *fast*

with the new

JOY 35-C
shot hole rig

Here's what you get with the new Joy Model 35-C Shot Hole Drilling Rig—

1 Wider variation of rotary speeds to give you the speed most economical for the formation being drilled, and the fastest penetration.

2 Easy replacement or adaptation—entire machine is built as a group of unit assemblies, each of which can be replaced or exchanged independently.

3 Extreme portability—a lightweight machine, mounted on a short—wheelbase truck to let you get in fast, rig up fast, move out fast.

4 Built to the high standards of all Joy motorized drill rigs to make operation easier, to reduce maintenance time and cost, and to give longer life—the Joy 35-C.

Why not get more information today on this outstanding new shot hole rig. Write *Joy Manufacturing Company, Oil Field Drill Division, P. O. Box 7204, Inwood Station, Dallas, Texas.* In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

Write for FREE Bulletin 28-83

Manufacturing and Service Facilities at 6540 Hines Blvd., Dallas, Texas

Consult a Joy Engineer.

For PORTABLE ROTARY DRILLS, AIR COMPRESSORS, GAS GATHERING COMPRESSORS, PORTABLE LIGHTING LINES

WSW 08247-133

JOY

WORLD'S LARGEST MANUFACTURER OF CORE DRILLS AND MOTORIZED DRILL RIGS SINCE 1851

got

GAS LIFT

Proved in thousands of wells to be the most economical method of secondary recovery!

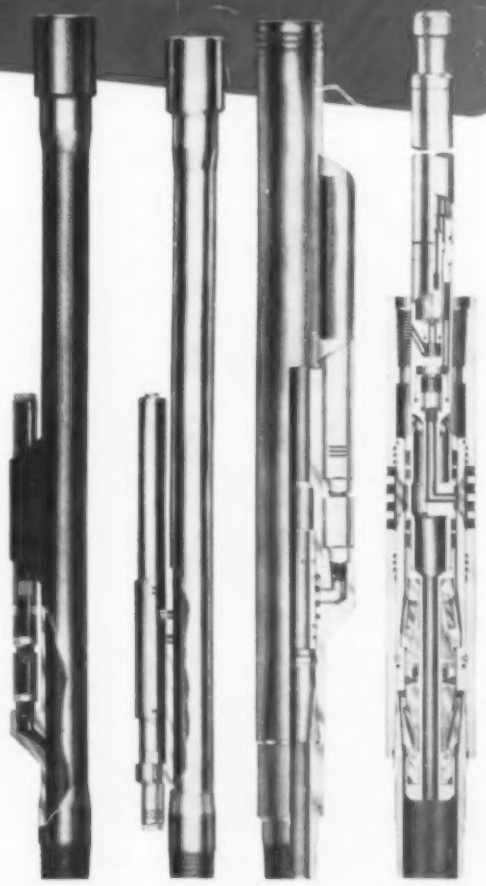
Intermitting | Continuous Flow | Balanced Port | Piston-type

Records of majors and independents **prove** the superiority of GOT Gas Lift . . . **prove** that it costs less to buy, less to install, less to operate and maintain than any other type of artificial lift equipment.

In reflecting longer valve life and low maintenance costs, these records clearly show the value of **protected bellows*** in pressure charged gas lift valves. They show the benefits of interchangeable and easily replaceable parts, of all-monel construction, and of design features that simplify field re-pressuring and repair.

GOT Gas Lift is applicable to **your** operations, also, and will reduce your lifting costs just as it has for so many others. GOT pressure charged gas lift valves are furnished in bellows and piston types to meet all of your well conditions. Pressure operated or fluid operated, they are supplied in standard and "junior" sizes to comply with any pipe program. Regular and wire line-operated mandrels are furnished in all tubing sizes, for tubing or casing flow. For complete details, ask your GOT representative or write for Catalog No. 156GL.

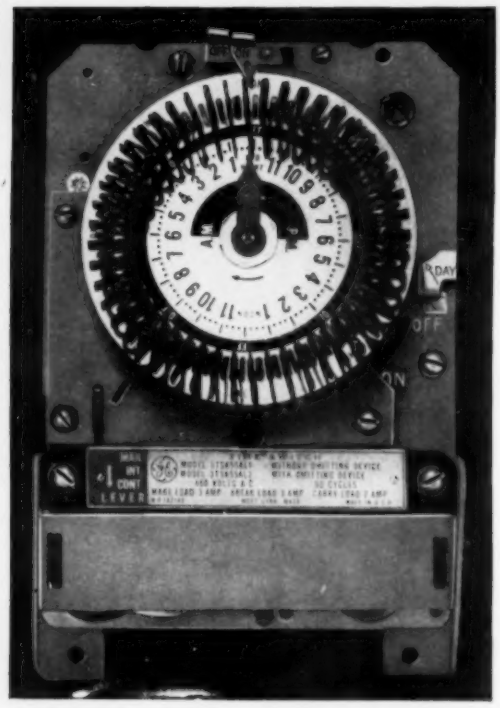
* Patents No. 2339487, 2519242.



Standard | Fluid Operated | Wire Line Operated | Wire Line Retrievable

Garrett Oil Tools, Inc.
P. O. BOX 2427 • LONGVIEW, TEXAS

DIVISION OF USI U. S. INDUSTRIES, INC
New York, N. Y.



COMBINATION TIMER performs in one device the same functions as a program and a sequence timer.

GENERAL ELECTRIC OFFERS . . .

Easy-to-set program timer on oil-well pumping starters

Setting the pumping cycle is easier with a General Electric oil-well pumping starter. The separate timer door in the G-E enclosure allows changing or setting the timer without opening the main enclosure.

ON-OFF OPERATION is controlled with the G-E combination timer by just flipping the toggle tabs toward or away from the center of the dial. Even with a gloved finger the tabs are easy to set. The full set of tabs program the pumping over 24 hours and in pumping periods as short as 15 minutes. The tabs clearly show the operating time settings.

SEQUENCE RESTART after power failure is provided automatically with the General Electric combination timer. No settings or adjustments of restarting intervals are necessary. Automatic sequence restart helps prevent overloading of the power supply caused by several motors restarting at the same time.

FOR COMPLETE INFORMATION on the G-E oil-well pumping starter, contact your nearest General Electric Apparatus Sales Office or Distributor. Or, write Advertising Section 733-28, General Purpose Control Department, Bloomington, Ill. Ask for bulletin GEA-6410.

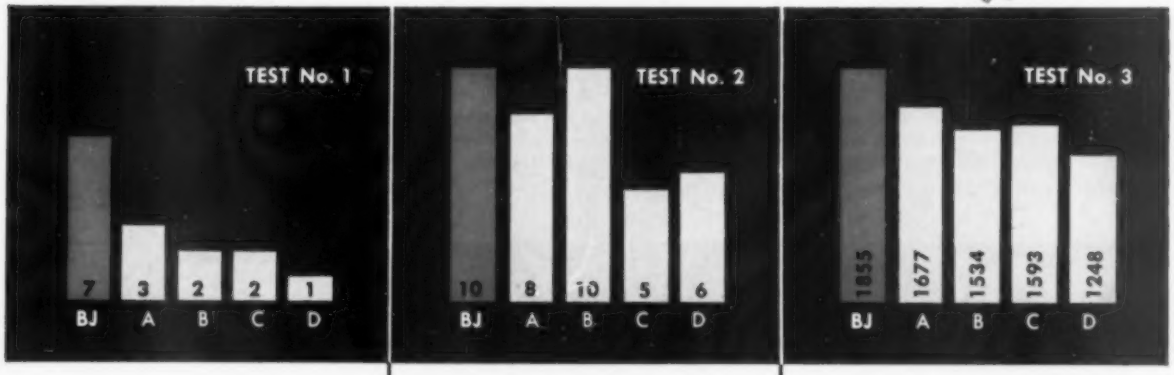
GENERAL ELECTRIC

NEW PROOF

BJ Red Top Tong Dies

last longer, grip better!

In the last three months, BJ Red Top and four other leading brands of tong dies have been given a series of exhaustive performance tests. Dozens of each brand of dies were purchased at random through regular supply houses. A special tong die testing machine developed by Byron Jackson for quality control was used to exert three forces – radial, tangential and impact – on die teeth in order to simulate the most exacting field conditions. The results are as follows:



TEST NO. 1. NUMBER OF BLOWS TO SHEAR TEETH:

The testing machine produced heavy impact blows on a single tooth. These blows, kept at constant strength, were repeated until shearing took place.

TEST NO. 2. NUMBER OF BLOWS TO SPALL TEETH:

A series of heavy impact blows was made on a single tooth. These blows were repeated until spalling (chipping) took place. A rating of 10 indicates no spalling.

TEST NO. 3. FT-LBS IMPACT PER ROW TO CAUSE FAILURE:

Impact effect on a row of teeth rather than on a single tooth was studied. The ft-lbs impact force necessary to make each die unfit for use was recorded.

BJ engineers designed this tong die testing machine to measure impact and shear strength. A hydraulic piston applies radial, tangential and impact forces which are accurately measured by precision pressure gages.

Results Talk! These test results are scientific confirmation of the fact that higher grade materials, more efficient methods, and quality control produce a better tong die. Byron Jackson has put years of metallurgical research into finding the best materials and design. BJ is the *only* tong die manufacturer that operates a continuous tong die production line with specially-designed equipment for tong die machining, heat treating and quality control. Next time, reach for BJ Red Top.

BJ

Byron Jackson

DIVISION OF BORG-WARNER CORPORATION

P.O. Box 2017A, Terminal Annex • Los Angeles 54, California

Houston • Fort Worth • Denver • New York

Sales engineers in all principal oil fields

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

B-171

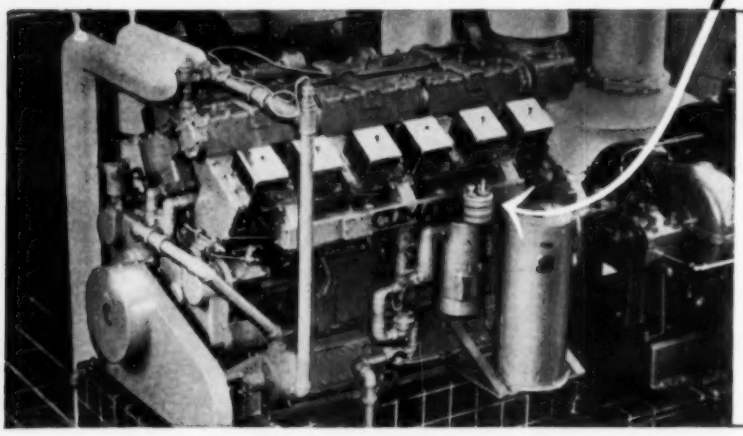
MARVEL INVERSE OILER–
Vital Part of World's Finest Engines

Engine manufacturers think so highly of the Marvel Inverse Oiler they have incorporated it as a vital unit in their engines' lubrication systems.

They have found that engines, equipped with Marvel Inverse Oilers, can be depended upon to give quick acceleration to save trip time . . . keep operating costs to a minimum . . . guarantee hours of continuous performance . . . keep "down-time" low by extending periods between overhauls.

The famous Climax Engines, one of which is pictured below, is an example. A truly fine performer, it is equipped with a Marvel Inverse Oiler for Marvel Mystery Oil—finest performing lubricant of all.

The Marvel Inverse Oiler feeds Marvel Mystery Oil in exact proportion to engine speed and load . . . properly lubricating valves and guides, preventing wear and sticking. Keeps upper piston rings free in their grooves . . . retards ring flutter . . . and cushions ring pounding which can result in ring breakages. Remember, it is the *oil* which must do these things and only Marvel Mystery Oil is blended for this purpose and for this oiler.



The Marvel Inverse Oiler

is an integral part of the Climax 12 cylinder, 171 H.P., 600 RPM GAS ENGINE. Operating off the intake manifold, this completely automatic Oiler feeds Marvel Mystery Oil exactly in proportion to engine loads . . . gives direct protection to the all-important upper cylinder areas.

This Chart shows the proper setting for constant load engines

BRAKE H. P. AT BELT	NAT. GAS CU. FT. PER HOUR	BUTANE GALLONS PER HOUR	GASOLINE GALLONS PER HOUR	M. M. OIL DROPS PER MIN.	M. M. OIL HOURS PER QUART
10	115.	1.07	1.12	4	228
15	172.5	1.60	1.68	6	152
20	230.	2.14	2.24	8	114
25	287.5	2.67	2.80	10	91
30	345.	3.21	3.36	12	76
35	402.5	3.74	3.92	14	65
40	460.	4.28	4.48	16	57
45	517.5	4.81	5.04	18	50
50	575.	5.35	5.60	20	45
60	690.	6.42	6.72	24	38
70	805.	7.49	7.84	28	32
80	920.	8.56	8.96	32	28
90	1035.	9.63	10.08	36	25
100	1150.	10.70	11.20	40	22
120	1380.	12.84	13.44	48	19
140	1610.	14.98	15.68	56	17
160	1840.	17.12	17.92	64	14
180	2070.	19.26	20.16	72	12
200	2300.	21.40	22.40	80	11
225	2587.5	24.00	25.20	90	10
250	2875.	26.75	28.00	100	9
275	3162.5	29.42	31.10	110	8
300	3450.	32.10	33.60	120	7

Chart shows total oil consumption

EXAMPLE:—If you use 805 cu. ft. of dry gas, 7.49 gallons of butane or 7.84 gallons of gasoline, your H.P. is about 70, so adjust oiler to feed 28 drops per minute. You will then receive about 32 hours per quart of MARVEL MYSTERY OIL.

If engine load increases after setting for normal load, oiler will automatically increase its feed, decreasing when load is lessened.

To determine drop count per oiler when more than one is used on an engine—divide recommended drop count by number of oilers.

NOTE: Guarantee on oiler is void if any other oil than MARVEL MYSTERY OIL is used. Some *engines* also carry this guarantee policy.

See Your Local Jobber or Oil Well Supply House

EMEROL MFG. CO.

242 West 69th Street
New York 23, N. Y.

THE BEST DUAL COMPLETION

BROWN DS-8

"both packers fully retrievable"

"top packer can be pulled independently of bottom packer"

BROWN RS-1

"the RS-1 can be run and set- then pull out of it, go back in & retrieve it"

BROWN OIL TOOLS, INC.
2214 CAMPBELL ST.
HOUSTON, TEXAS

DUAL STRING PACKER

"runs both packers simultaneously"

"saves time- saves money!"

For further information, write: Brown Oil Tools, Inc.

BOT

IF YOU HAVE A PACKER PROBLEM — BROWN CAN HELP

Top Performance at Rock Bottom Cost

WITH THE

GUIBERSON

TYPE B TUBING SPIDER

Stock sizes 1" to 3"; spiders are available on special order for 2" x 1" and 2 ½" x 1 ¼" parallel strings.

The Guiberson Type "B" tubing spider is a fast-handling, lightweight tool that can be handled by one man if necessary—and the cost of the "B" is lightweight, too. No other spider in its class offers greater economy, either initially or in the long run.

Despite its exceptionally light weight, the Type "B" spider will hold the longest string, and release instantly without sticking when you pick up. All slips fit the same bowl, and the "B" will not distort or damage tubing. Self-equalizing slips with hard, sharp teeth, give full, large-area contact, assuring positive grip, better load distribution and perfect release.

For positive performance, maximum protection, amazing handling ease and surprisingly low cost, you can count on the sure-grip "B" Tubing Spider.

THE GUIBERSON CORPORATION

ESTABLISHED 1919
DALLAS, TEXAS
U. S. A.

Sold by
Oil Field Supply Stores
Everywhere

fracture with Adomite

Well	Formation	Gallons Fracturing Fluid	Pounds Sand	Injection Rate BPM	Production, BOPD Before	After	30-60 Days After	6 Months After
A.	San Andres	10,000	10,000	5	2	28	35	—
B.	San Andres	15,000	21,000	5	4	54	120	65
C.	Springer Sand	6,000	12,000	3	8	49	51	51
D.	Penn. Cgl.	6,000	6,000	4	*	345	144	80
E.	Miss. Chat	6,000	12,000	10	Dead	435	306	192
F.	Miss. Chat	6,000	10,000	5	10	—	33	30
G.	Miss. Chat	6,000	12,000	10	*	—	330	360
H.	Clear Fork	10,000	20,000	6	*			51
I.	[illegible]							52
J.								99
K.								51
L.								68
M.								30

GET RESULTS LIKE THESE

Adomite®— and only Adomite does so many things so effectively

Seals the fracture face . . . minimizes fluid loss . . . no damage to formation.

Longer fractures . . . deeper penetration of sands.

Fewer sandouts . . . reduces fluid loss in rock matrix, prevents buildup of sand concentrations in the fractures.

Saves you money . . . utilizes your own lease crudes . . . saves transportation costs.

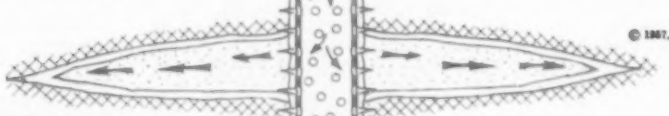
Decreases friction loss . . . low viscosity of Adomite-created fracturing fluids permits use of less pumping equipment than with viscous refinery residuals.

Reduces hazard of emulsions . . . emulsion-breaking characteristics are an important consideration to many producers.

Adaptable to virtually all types of crude, Adomite is all you need to control fluid loss of kerosene, crudes, gelled crudes or refinery residuals.

Producers who say Adomite . . . stay with Adomite.

© 1957, Continental Oil Company



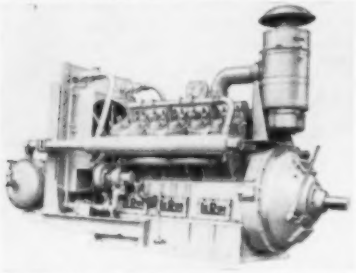
Get greater profits from your next fracturing job

TELL YOUR SERVICE COMPANY TO USE Adomite

NEW Drilling and Producing Equipment

Air Drilling Compressors Specially Designed. Air drilling compressors designed especially for the petroleum industry have been announced by the Le Roi Division, Westinghouse Air Brake Company. The new line includes three different models, which can be compounded to produce various capacities and pressures.

In order to produce an air compressor durable enough to withstand 24-hr drilling service with the minimum of maintenance, Le Roi departed from conventional compressor design. New compressors follow the basic patterns of the Le Roi line of RX series engines.



Early tests proved that portables were not designed for such continuous, heavy-duty service. Industrial stationary compressors of equivalent capacities, due to their size and weight, made transportation and set-up very difficult.

The new air drilling compressors are equipped with oil filters and water-cooled discharge manifolds. Other features include conservative speeds (870 to 900 rpm), and sufficient intake air cleaning capacity for extreme dust conditions. Because of the continuous-duty operation of drilling equipment, full-flow oil filters with replaceable elements are offered as standard equipment.

Smallest unit, the 200S1, is a single-stage machine with a rated capacity of 620 cfm at 100 psi. Its dry weight is 6025 lb. The 300S1 is also a single-stage machine and has a capacity of 930 cfm at 100 psi. Dry weight is 7450 lb.

Largest compressor, the 350S2, is a two-stage unit. It has a free air delivery capacity of 850 cfm at 250 psi and a weight of 7600 lb. *Le Roi Division, Westinghouse Air Brake Company.*

Circle number (1) on reply card.

Coupling for Grooved End Pipe. A new flexible coupling for grooved end pipe is now marketed by Charles E. Manning.

In sizes 1 in. to 8 in., the Alumiron Coupling is available in either malleable iron or aluminum and is furnished with Buna N or Neoprene gaskets. For use on steel, aluminum, cast iron, wrought iron, and spiral weld pipe, the Alumiron can be quickly coupled or uncoupled by means of two bolts which pass through the coupling halves. Use includes long, surface runs over rough, uneven country on service pipe to drilling rigs, Christmas tree, tank farms, stock and transfer lines, gathering lines, and waste disposal. *Charles E. Manning Company.*

Circle number (6) on reply card.

New Line Pumping Units. A line of beam-type pumping units is being introduced by Aztec Manufacturing of Fort Worth, Texas. Initial production will be concentrated on smaller size units up to 7000 lb API polished rod load capacity. The line will be rapidly expanded until a full range of sizes is available. *Aztec Manufacturing Company.*

Circle number (7) on reply card.

Centrifuge Core Cleaner. This new Centrifuge Core Cleaner will clean core samples cut from an oil-bearing formation and is adaptable to cleaning any type of porous material, such as filters, where 100 percent of carbon contaminate must be removed.

In recent tests, cores of approximately even porosity (18 to 23 percent) were saturated with 40 gravity oil. After approximately 20 min, the Centrifuge Core Cleaner had removed 100 percent of the oil.

The core basket will hold up to 18 1-in. samples, cubical or cylindrical. Centrifuge is self-balancing to prevent injurious vibration when less than the maximum number of samples are being cleaned. *Exline Engineering Company.*

Circle number (2) on reply card.

Hard-Face Well Rod. Kutrite, a new sintered carbide composite rod, has been developed by B & W Metals. These crushed tungsten rods are utilized for building up fishing and cutting tools used in oil well drilling operations. Kutrite rods have been used to build up small coring heads and seismograph bits and the world's largest mill. Rods have a matrix tensile strength of 100,000 psi and features a guaranteed hardness of 91.08 to 93 Rockwell A. *B & W Metals Company.*

Circle number (3) on reply card.

Valve Designed for Volume Meters. A special type three-way valve which eliminates "slippage" is now standard equipment on Rolocheck Meters and Rolocheck Metering Separators, made by Rolo Manufacturing. Called the Neutral Position 3-Way Valve open port closes before the other port opens. On the Rolocheck Meter, this insures against the possibility of both valve ports being open at one time during the valve switching operation. Oil cannot by-pass the meter with this valve, thus assuring maximum meter accuracy. *Rolo Manufacturing Company.*

Circle number (4) on reply card.

New Policy — Faster Service

Commensurate with our policy of better aids for the petroleum industry, we are initiating with this issue a new faster reader inquiry system to aid in supplying you with information concerning new products, new literature, and products advertised in this issue.

Our goal with the new system is to get your request in the manufacturers' hands as soon as possible. Our sights are set high — your request to the right man in 10 days.

Along with this, look for more information — in New Equipment — better coverage of the latest tools in drilling, the newest in production, and outstanding new services that are being made available each month for your improved operation.

— James A. LeVelle
Engineering Editor

Liner Mill Utilizes Fast-Cutting Process. Servco Liner Mill has been developed to mill up liners, both inside the casing and below the casing shoe.

Fast cutting action is largely due to the use of Servcoloy, a revolutionary method of suspending particles of tungsten carbide in a tough elastic matrix so that hundreds of cutting edges are always in contact with the surface. New particles are automatically exposed as particles are worn away or torn from the matrix. *Servco Corporation.*

Circle number (8) on reply card.

Resistivity Meter Measures Mud. Model 88 Fann Resistivity Meter is usually small and light and is carried like a camera. The transparent sample holder functions with samples as small as .75 cc and is easy to clean. *Fann Instrument Corporation.*

Circle number (9) on reply card.

Offshore Survey Tool. A unique tool for exploring the ocean floor and sediments 80 ft or more beneath it has been developed by research scientists of Socony Mobil.

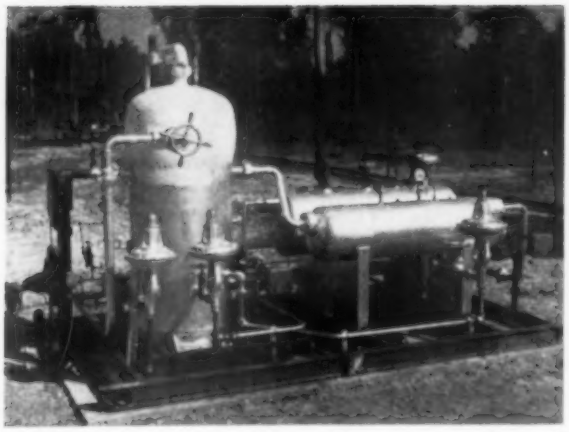
Called the Marine Sonoprobe, instrument will be made available to the oil industry under arrangements by Socony Mobil and its southwestern affiliate, Magnolia Petroleum Company, with Fairchild Aerial Surveys, Inc., which will offer surveys world-wide as a commercial service.

The Marine Sonoprobe is similar in construction and operation to conventional recording echo sounders used for measuring the depth of water but has been specially designed to obtain echoes from beneath the ocean floor. The sea floor and layers beneath it are displayed on a small television picture tube and are also recorded as a continuous profile on electrosensitive paper.

Instrument was originally designed, built, and tested for underwater geological research at Magnolia's Field Research Laboratory and has been applied in offshore oil exploration. Magnolia has also used it for mapping the routes of underwater pipelines and in surveying sites for offshore drilling platforms, for which pilings must be driven into the sea bottom.

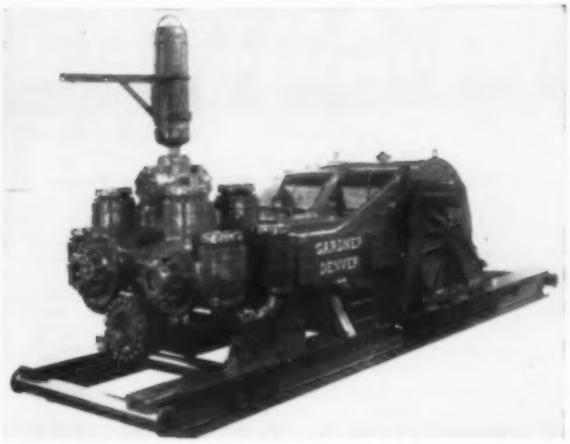
Experience with the Marine Sonoprobe indicates that it will provide reliable maps of shallow salt domes, shallow faults, buried ancient channels and valleys, and shallow geological structures. *Fairchild Aerial Surveys, Inc.*

Circle number (5) on reply card.



Low-Temperature Separation Unit. Model "MDH" Cold-Frac System, for extremely high-pressure wells, wells producing wax and/or salt water, and wells with a pressure life of three to five years, has been announced by Black, Sivalls & Bryson. New unit includes an improved liquid knockout, which has greater scrubbing efficiency and eliminates wax and salt water problems, and a new heat exchange designed specifically for the new unit, which achieves maximum cooling with minimum pressure drop through counterflow with cold sales gas. *Black, Sivalls & Bryson, Inc.*

Circle number (10) on reply card.



Mud Pump, 1250 Hp. Addition of a new 1250 hp mud pump to its line is announced by Gardner-Denver. Known as the GH-GXH, the new model is designed with an 18-in. stroke for heavy-duty drilling service.

The GXH delivers from 884 gpm at 2060 psi, using master 7¾-in. liners, to 500 gpm at 3642 psi with 6-in. liner. Hydrostatic tests at 9000 psi on discharge and at 4500 psi on suction prove ample working pressure ratings of 4500 psi on discharge and 2250 psi on suction. *Gardner-Denver Company.*

Circle number (14) on reply card.

Foam Nozzle. A multi-purpose, fire-fighting nozzle made by National Foam System is attracting the attention of fire protection engineers in many industries.

The PW-50 Nozzle can be shifted quickly to straight stream or spray stream operation, using either foam solution or water alone. It may be mounted on foam trucks, fire boats or crash trucks, or may be used with fixed piping near process units in refineries and chemical plants.

Depending upon the operating pressure, volumes of up to 4600 gpm of foam can be obtained. Range of straight foam stream extends to 200 ft, while spray stream operation produces an effective foam spray pattern as long as 88 ft.

The nozzle weighs only 50 lb. It is 40 in. in overall length, and is equipped with a 2½-in. connection for hose or pipe. *National Foam System, Inc.*

Circle number (11) on reply card.

Repairing Broken Machinery. Devcon, the plastic steel, is a combination of 80 per cent steel and 20 per cent plastic.

Devcon was developed originally for use by the metal working industry for making tools, jigs, fixtures, molds, dies, models and for similar uses. It was soon found that Devcon was an excellent adhesive for metals and could be used for bonding steel, iron, bronze, brass, aluminum, and lead. As a result, Devcon is now being used in large quantities for rebuilding broken machinery, filling large and small holes in castings, building up worn metal surfaces on machine tools, repairing stripped threads, bearings, etc. *Devcon Corporation.*

Circle number (12) on reply card.

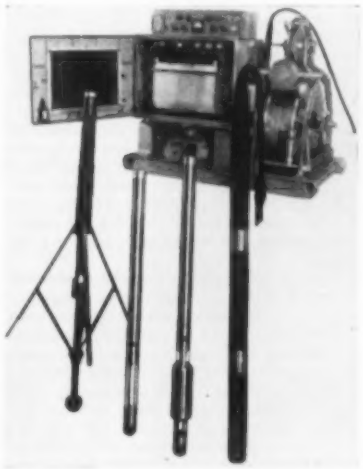
Lost Circulation Material. Plug-Git is a processed, shredded hardwood fiber designed to stop loss of circulation. Advantages of Plug-Git are ease and quickness of mixing; coarseness; matting ability and strength. It does not deteriorate or plug the pump, is compatible with other mud products, and forms an efficient seal. *Baroid Division, National Lead Company.*

Circle number (13) on reply card.

Five Hp Down-Hole Pump. Reda Pump has developed a new 5-hp oil well pump that will pump from depths up to 1500 ft. Pump will provide capacities in excess of 800 bbl per day and is available in two models for different well depth ranges. Unit will fit in well casings as small as 5½ in. *Reda Pump Company.*

Circle number (15) on reply card.

Portable Well Loggers. Well Instrument Developing Company has added dry-hole, gamma-ray, temperature and caliper logging tools to its lines of Widco Loggers. New tools are readily adaptable to the Widco Electric Loggers, whether they are of the type recording a simplified two-curve electric log for geological correlations or the investigation of ground water supplies, or of the type giving multiple-resistivity and potential curves for the logging of wells drilled for oil or other minerals. *Well Instrument Developing Company.*



Circle number (16) on reply card.

Wall Scratcher with Upturned Wires. As casing, equipped with straight wire scratchers, is run into the well, there is agitation of the gelled mud and mud filter cake on the wall of the hole. To minimize this condition, B and W Hinged (or solid) Nu-Coil Scratchers are now furnished with upturned wires. No scratching is done as casing is lowered into the well or until circulation has been established and the casing is reciprocated. *B and W, Inc.*

Circle number (17) on reply card.

Insulating Union. Insulating forged steel unions, used to prevent electrolytic corrosion due to flow of electric current along pipelines, are now available from W-S Fittings Division. Unions are manufactured in 3000-lb class, sizes ¼-in. to 3-in. in screw-end and socket-welding types. The gasket which seals the union joint, and which is in contact with the fluid in the pipe, is made of Teflon. *W-S Fittings Division, H. K. Porter Company, Inc.*

Circle number (18) on reply card.

Crude Oil Monitor Control Percent Water. An adaptation of the capacitance product analyzer, a newly introduced crude oil monitor, continuously inspects the bs&w content of crude oil being delivered from the separator and/or treating equipment to tankage. On exceeding bs&w specifications, monitor actuates control valves to reroute crude to wet-oil storage or treaters.

Monitor assembly includes a pipeline probe and a control instrument. Essentially, the probe is a fixed capacitor, sensitive to change in the dielectric constant of materials passing between the centrally located electrode and the wall of the surrounding pipe. Range of the standard monitor is 0 to 3 percent bs&w with 2-min time delay. Both specifications can be varied to suit the installation requirements. For bs&w ranges up to 5 percent, the instrument response is essentially linear. *Instruments, Inc.*

Circle number (19) on reply card.

the Refining

Refining

NEW LITERATURE

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Latex Cementing Service. A 4-page, color folder on Cealment, a new specialized cementing service by Dowell, has been issued. Bar charts are used to point out the advantages claimed for Cealment over Portland cement — superior bonding, greater resiliency, low fluid loss, permanency, and resistance to contamination. *Dowell Incorporated.*

Circle number (20) on reply card.

Wire Rope Slings and Assemblies. "Roebling Wire Rope Slings and Assemblies," a 52-page, color catalog, has been published. The booklet, a new concept of sling cataloging, was designed for quick and accurate sling selection and ordering. It was organized around a simplified coding system designed to be helpful to those concerned with materials handling problems. *John A. Roebling's Sons Corporation, subsidiary of the Colorado Fuel and Iron Corporation.*

Circle number (21) on reply card.

Basic Sediment & Water Monitor. A 4-page, color brochure has been announced by Instruments, Inc., on Gulf Research and Development Company's BS&W Monitor for measuring and controlling the bs&w content of crude oil at automatic custody transfer installations. A photo, diagram, and charts describe the monitor, how it operates, and a typical installation. *Instruments, Inc.*

Circle number (22) on reply card.

Annunciator System. Scam Instrument has issued a completely new catalog of its self-policing visual and audible annunciator systems. In addition to listing the Scam "De-Line," "Du-All," "S" Line, and "Explosion-Proof" alarm systems, the catalog also contains detailed information on what to consider when selecting an annunciator, wiring diagrams for alarm units, sample alarm sequences which may be common to many plants, and much other valuable engineering and installation data. *Scam Instrument Corporation.*

Circle number (23) on reply card.

Seven-Way Selector Valve. Win-Well has pointed out the possibility of automation in oil production by use of its new Seven-Way Multi-Port Rotary Selector Valve in a 4-page brochure. Flow Charts on typical installations plus other illustrations are included. *Win-Well Manufacturing Company.*

Circle number (24) on reply card.

Locking Tool. Otis Pressure Control has published a bulletin on its new Type W Otis Removable Locking Mandrel Assembly, a tool used to lock and pack off Otis removable subsurface flow controls. The literature describes the design and applications of the new tool, and also contains several illustrations of the assembly. Type W locking assembly is used to lock and pack off Otis removable bottom-hole regulators, Otis removable tubing safety valves ("storm chokes"), and Otis removable bottom-hole chokes. *Otis Pressure Control, Inc.*

Circle number (25) on reply card.

Diesel Engines. Detroit Diesel industrial power units and fan-to-flywheel engines for use in hundreds of standard and special applications are fully described and illustrated in a new brochure. Covered are horsepower ratings, dimensions, and accessory information on single and multiple-engine models ranging from 56 to 761 rated brake horsepower. *Detroit Diesel Engine Division, General Motors Corporation.*

Circle number (26) on reply card.

Vertical Turbine Pumps. "The Answers to Your Questions About Layne Vertical Turbine Pumps" is a 72-page booklet published by Layne & Bowler. It is a series of nine articles on deep well centrifugal pumps written by Axel O. Fabrin, chief engineer for the company. Numerous photos, charts, diagrams, and tables are included. *Layne & Bowler, Inc.*

Circle number (27) on reply card.

MEN OF FORESIGHT READ NEW EQUIPMENT

MEN OF PROGRESS READ ADVERTISEMENTS

MEN OF ACTION USE READER SERVICE CARDS

Plastic Pipe for Petroleum Industry. Kraloy's 4-page bulletin on its rigid PVC plastic pipe for use by the petroleum industry describes it as all-purpose pipe for oil country. Diagrams are among the illustrations. *Kraloy Plastic Pipe Co., Inc., division of the Seamless Rubber Co.*

Circle number (28) on reply card.

Oil Industry Story. Gulf Oil has begun distribution of a booklet entitled, "The Industry Nobody Really Knows," aimed at giving consumers of all petroleum products a more realistic understanding of how the oil industry actually gets its job done. The story is told in terms of the individual experiences of independent operators who have only a contractual relationship with any major oil company. Publication separates fact from myth in explaining how oilmen, who comprise "the largest industrial enterprise ever known," carry on their business.

Written by Craig Thompson, free-lance magazine writer and author, the collection of facts for this story involved more than 8000 miles of travel and literally hundreds of hours of interviews with persons ranging from lease buyers, royalty owners, ranchers, truckers, and jobbers to junk buyers, bankers, producers, and service station owners, among others.

This comprehensive story of the oil industry deals with many facets of this industry which until now have been disclosed largely only within the industry. It presents a dramatic picture of what might be termed the disintegration of an intergrated industry. *Gulf Oil Corporation.*

Circle number (29) on reply card.

Low-Temperature Separation. Publication of a catalog on the new Type B Econ-O-Max Unit for small gas condensate wells — low flowing temperatures and low production rate (½ to 3 MMSCFD) — has been announced by Black, Sivalls & Bryson. A streamlined version of the larger, more complex Cold-Frac System, the new Econ-O-Max Unit consists of a compact, specially designed vertical separator with internally located liquid-level controllers and effective gas scrubbing. *Black, Sivalls & Bryson, Inc.*

Circle number (30) on reply card.

Pumping. Two new bulletins, describing the National Types E-21 and E-24 Pumping Units, complete the present series of six bulletins covering the "E" line of crank counterbalanced units ranging from the E-9 through the E-24. The six basic units described in this series are designed to meet pumping requirements that can be specified within API ratings of 8900 to 24,000 lb for the beam and 40,000 to 228,000 in.-lb for the gear reducer. Each bulletin gives important dimensional and rated land data. *The National Supply Company.*

Circle number (31) on reply card.

Engine Case Histories. Four new engine case histories have been published by Le Roi Division, Westinghouse Air Brake, bringing to eight the total number of its engine case histories. The two-page case histories use pictures and drawings to illustrate applications, which include: Air conditioning, gas boosting, generator sets, oil well pumping, and oil well drilling. *Le Roi Division, Westinghouse Air Brake Company.*

Circle number (32) on reply card.

Fortieth Anniversary of Valve. Fortieth anniversary of the invention of the lubricated plug valve has been commemorated in a colorful, 20-page edition of *The Flow Line*, a Rockwell publication. The magazine describes how Sven Nordstrom, a young Swedish engineer, invented the lubricated plug valve after his battle with a frozen plug cock ended with a bent wrench and the plug still immovably stuck. *Rockwell Manufacturing Company.*

Circle number (33) on reply card.

Pneumatic Clutch and Brakes. Fawick has released a new bulletin describing the complete line of package applications for modernization of presses and similar machinery with pneumatic clutch and brake. Bulletin contains data on how to select the proper application for a press. *Fawick Airflex Division, Fawick Corporation.*

Circle number (34) on reply card.

Gasket Catalog. As a help to users of gaskets, shims, and washers, Chicago-Wilcox Manufacturing has released a 28-page catalog illustrating and describing these products in a variety of styles, shapes, and materials.

Catalog includes data on ring, cylinder head, double jacket, corrugated metal, plain solid, self-sealing, and special types of gaskets as well as gaskets cut from a wide range of materials. A valuable feature of the book, it is stated, is a complete section listing more than 1500 stock dies available which can often save users the cost of dies in meeting their requirements. *Chicago-Wilcox Manufacturing Company.*

Circle number (35) on reply card.

VERTICAL PUMPS

HARSHAW

FLUORIDES

Boron Trifluoride

Hydrofluoric Acid
Anhydrous...Aqueous

Harshaw fluorides can well be described as the modern version of the magic genie of old. They have the power, speed and versatility of the legendary servant of the lamp.

Harshaw fluorides serve many industries advantageously. Their top ranking is the result of rigidly controlled uniformity and quality.

WRITE FOR

Harshaw's 40-page book on Hydrofluoric Acid Anhydrous. It provides helpful data on the safe handling and use of H. F.

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Chicago • Cincinnati • Cleveland • Detroit • Houston
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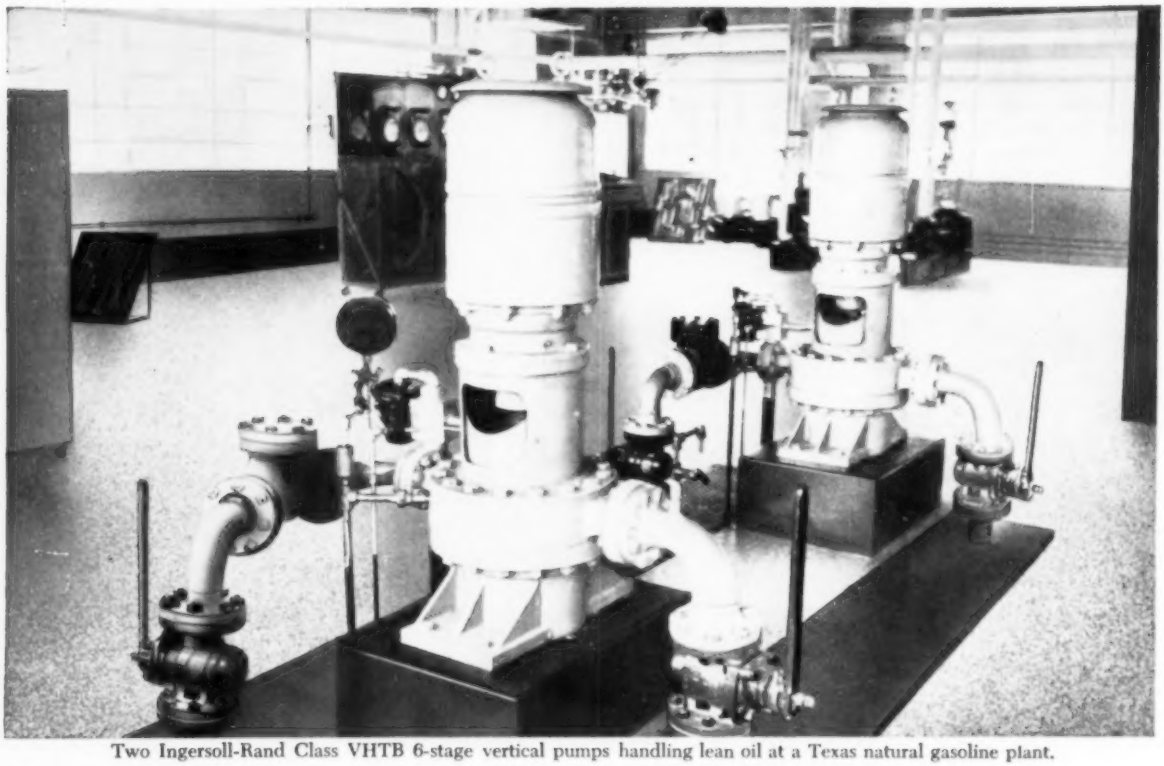
Here are many more production-controlled, high-quality fluorides:

Ammonium Bifluoride
Ammonium Fluoborate
Antimony Trifluoride Sublimed
Barium Fluoride
Bismuth Fluoride
Boron Trifluoride
Boron Trifluoride Complexes
Chromium Fluoride
Copper Fluoborate
Fluoboric Acid
Fluorine Cells
Fluorinating Agents
Frosting Mixtures
Hydrofluoric Acid Anhydrous
Hydrofluoric Acid Aqueous
Hydrofluosilicic Acid
Lead Fluoborate
Metallic Fluoborates
Potassium Bifluoride
Potassium Chromium Fluoride
Potassium Fluoborate
Potassium Fluoride
Potassium Titanium Fluoride
Silico Fluorides
Sodium Fluoborate
Tin Fluoborate
Zinc Fluoborate
Zinc Fluoride

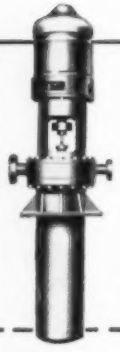
New Projects in | refining
gas processing

VERTICAL PUMPS



Two Ingersoll-Rand Class VHTB 6-stage vertical pumps handling lean oil at a Texas natural gasoline plant.

to lower your pumping costs



CLASS VHTB
Pressures: to 1500 psi
Capacities: 25 to 325 gpm
Temperatures: to 750°F.

Vertical, multi-stage diffusor-type unit. Single-suction impellers mounted back-to-back for axial hydraulic balance. Stuffing box under suction pressure.

For low capacities at high heads on process, boiler feed, hydraulic and similar applications.

CLASS VP
Pressures: to 750 psi
Capacities: 10 to 350 gpm
Temperatures: to 750°F.

Vertical, multi-stage, diffusor-type construction. Single-suction impellers with throttling sleeve balancing device to reduce axial thrust and provide suction pressure at stuffing box. Entire pumping element removable without disturbing suction and discharge piping.

For low capacities at medium high heads on applications such as process, boiler feed, and heater drain work.

Designed specifically for low-capacity high-head applications, these Ingersoll-Rand vertical process pumps are engineered with a background of process pump experience. They are manufactured in the most modern of pump plants to deliver years of efficient service with a minimum of down time and maintenance expense.

Features include: "Double-Case" construction with segmented diffusor-type inner casing for complete radial hydraulic balance and minimum bearing wear... Positive aligning feature for perfect positioning of inner casing segments... Rotor assembled without prestressing shaft to eliminate all possibility of shaft distortion. Available in bronze fitted, all iron, carbon steel, and stainless fitted materials to cover a wide range of process services.

Ask the Ingersoll-Rand engineer to show you these and other features which make Ingersoll-Rand pumps your best bet for low cost year-in, year-out service.

Ingersoll-Rand

10-376

11 BROADWAY, NEW YORK 4, N.Y.

COMPRESSORS • GAS & DIESEL ENGINES • AIR & ELECTRIC TOOLS • CONDENSERS • PUMPS • ROCK DRILLS • VACUUM EQUIPMENT

New Projects in refining gas processing petrochemicals

Phillips Petroleum Company and Pacific Petroleums, Ltd., plan to build a $30,000,000 natural gas liquids processing plant at Taylor Flats, British Columbia. Equipment will include distillation, catalytic desulfurization, catalytic reforming, dehydrogenation, butane isomerization, alkylation, and blending and storage facilities. This plant will be the most complex yet built for processing natural gasoline.

The Mandan Refinery of Standard Oil Company (Indiana) will start production of jet fuel in late 1957 or early 1958. A new 96,700-bbl tank for gasoline storage will release two smaller tanks for jet fuel blending and storage. Other new facilities will include pumps, pipelines, and a loading rack within the refinery.

Standard Oil Company of California plans to build a $10,000,000 natural gas scrubbing plant near the Princess Field in southern Alberta. The plant will remove H_2S, CO_2, and other impurities from natural gas to be shipped through the new Trans-Canada pipeline system.

Shell Oil Company has awarded a contract to Kaiser Engineers for the design and construction of a Platformer and feed desulfurization facilities at Shell's Dominguez, California, refinery. To be onstream in early 1958, the unit will make about 12,000 BPD of gasoline blending component. **Shell** also plans a 2400 bbl per day sulfuric acid alkylation unit at its Anacortes, Washington, refinery. About 800,000 bbl per year of 115/145 grade avgas will be produced. Fluor Corporation will build the unit.

Another giant crude unit . . . Magnolia Petroleum Corporation will build a 100,000 BPD crude distillation unit at its Beaumont, Texas, refinery. Replacing smaller units, capacity of the 205,000 BPD refinery will not be increased. Foster Wheeler Corporation is engineering-construction contractor.

Richfield Oil Corporation is the latest entry into the Northwest Washington refining picture, now negotiating with the Tulalip Indians for a site near Everett. Other plants planned or building in the Puget Sound area of Washington include:

- U. S. Oil & Refining Company, with a 15,000 bbl per day plant being built near Tacoma.
- The Texas Company, to build a 35,000 bbl per day refinery at Anacortes in 1957.
- Standard Oil Company of California, planning a 60-100,000 bbl per day refinery at Everett, slated to begin operations in 1958.

Humble Oil & Refining Company is moving heavily into petrochemicals. Already a key producer of aromatics and butyl rubber, latest plans are for an 80-million pound per year ethylene recovery unit, to be operated in conjunction with the 55,000 bbl per day catalytic cracker now under construction. Announced in December were plans to build a 24-million gal per year benzene plant.

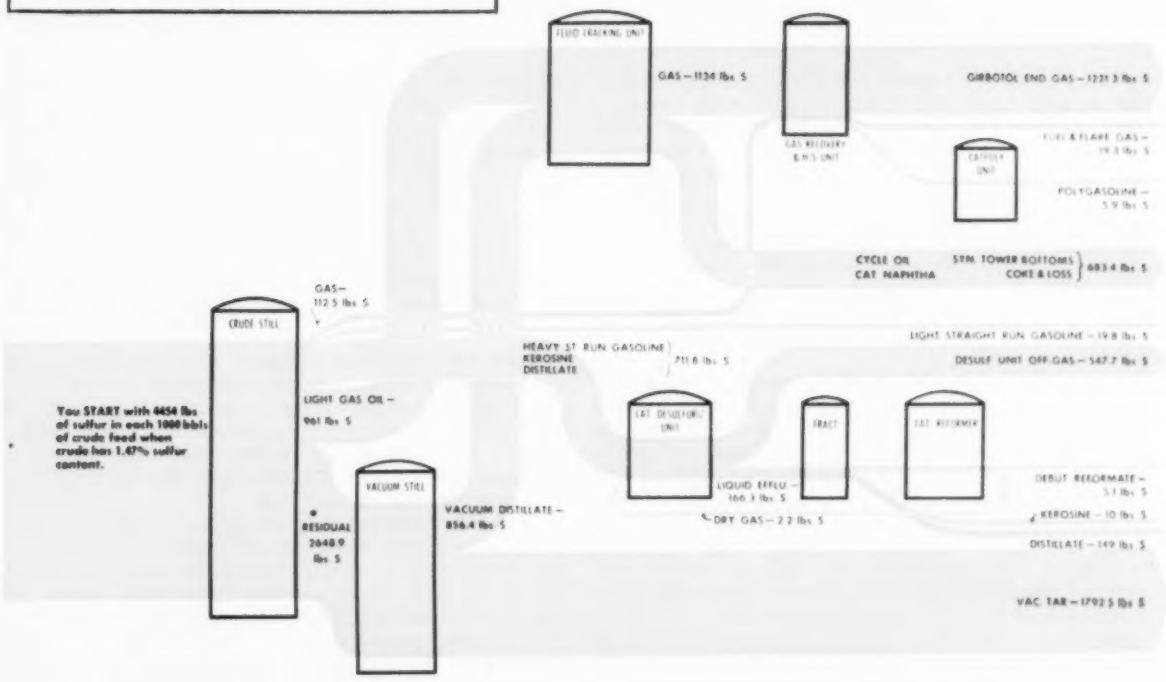
Standard Oil Company (New Jersey) has reached agreement in principle with the Norwegian government for construction of a 40,000 bbl per day fuel products refinery on Oslo Fjord. Subject to Parliament's approval, construction of the $29 million plant will start in 1958. Jersey will form a new subsidiary to operate the refinery.

Shell Chemical Company has initiated its 120 million lb per year isopropyl alcohol expansion by announcing a 70-million lb per year plant to be built at Dominguez, California, to be completed this year. Balance of the expansion will be built at Norco, Louisiana, and Houston, Texas. Houston will add 20 million lb per year in the near future; plans for the Norco plant are not yet announced.

Construction Notes in Brief . . .

Construction Contractor	Engineering and Design Company	Location	Type of Plant or Unit	Rated Capacity	Cost	Scheduled for Completion
		British American Oil Company, Ltd.				
—	Atlantic Refining Co.	Edmonton, Alberta, Canada	Catformer	2000 BPD	—	Late 1957
		Callery Chemical Company (Mine Safety Appliance Company Subsidiary)				
Ralph M. Parsons Co.	Same and Callery	Muskogee, Okla.	Rocket Fuel	—	$38,000,000	—
		Douglas Oil Company				
Macco Corp.	Same and UOP	Bakersfield, Calif.	Unifiner	—	$400,000	Mid 1957
		General Aniline and Film Corporation				
SD Plants, Inc.	Same and Scientific Design Co.	Linden, N. J.	Ethylene Oxide Ethylene Glycol	60 MM lb/yr 35 MM lb/yr	$8,000,000	Early 1958
		Imperial Oil Company, Ltd.				
Bechtel Corp.	Same and C. F. Braun Co.	Sarnia, Ontario, Canada	Steam Cracker and Assoc. Facilities	150 MM lb/yr (ethylene, plus max. butadiene and butylenes)	$25,000,000	Mid 1958
		Socony Mobil Oil Company				
J. F. Pritchard & Co.	Same and Socony	Augusta, Kansas	Sovaformer	9000 BPD	—	Early 1958
M. W. Kellogg Co.	Same	Buffalo, N. Y.	H_2SO_4 Alkylation	2435 BPD	—	"
J. F. Pritchard & Co.	Same and Socony	Casper, Wyo.	Sovaformer	3000 BPD	—	"
			Fuel Oil Hydrodesulfurization	3250 BPD	—	"
Fluor Corp., Ltd.	Same	Trenton, Mich.	H_2SO_4 Alkylation	3500 BPD	$3,500,000	Early 1958
		Standard Oil Company (Indiana)				
Arthur G. McKee Co.	Same and Standard	Whiting, Ind.	Ultraformer #3	21,000 BPD	—	Early 1958
		Tidewater Oil Company				
—	Houdry Process Corp.	Associated, Calif.	Houdriformer	22,500 BPD	—	Jan. 1958
		U. S. Oil & Refining Company				
Holmes & Narver Co.	Houdry Process Corp.	Tacoma, Wash.	Houdriformer	2 5-3000 BPD	—	May 1957
		Wyandotte Chemicals Corporation				
Fluor Corp., Ltd.	Same	Baton Rouge, La.	Chlorine-Caustic	—	$20,000,000	Late 1958

Where the Sulfur Goes


FLUID CRACKING UNIT
GAS – 1134 lbs S
GAS RECOVERY & H2S UNIT
GASOL END GAS – 122.3 lbs S
FUEL & FLARE GAS – 19.3 lbs S
POLYGASOLINE – 5.9 lbs S
CYCLE OR CAT NAPHTHA
SYN. TOWER BOTTOMS
COKE & LOSS
683.4 lbs S
GAS – 112.5 lbs S
CRUDE STILL
You START with 4454 lbs of sulfur in each 1000 bbls of crude feed when crude has 1.47% sulfur content.
LIGHT GAS OIL – 961 lbs S
RESIDUAL 2648.9 lbs S
VACUUM STILL
VACUUM DISTILLATE – 856.4 lbs S
HEAVY ST. RUN GASOLINE
KEROSINE
DISTILLATE
711.6 lbs S
LIGHT STRAIGHT RUN GASOLINE – 19.8 lbs S
DESULF. UNIT OFF-GAS – 547.7 lbs S
CAT. DESULFUR. UNIT
FRACT.
CAT. REFORMER
LIQUID EFFLU – 166.3 lbs S
DRY GAS – 2.2 lbs S
DEBUT REFORMATE – 5.1 lbs S
KEROSINE – 10 lbs S
DISTILLATE – 14.9 lbs S
VAC. TAR – 1792.5 lbs S

How to save up to 7¢ per barrel on lead

Ethyl Research studies show you can increase the octane number by decreasing the sulfur . . . and use less lead!

Getting the most from your lead is a complex business involving among other things, hydrocarbon blending and control of sulfur concentration in the fuel to be leaded. The Ethyl Corporation is constantly studying the interrelation of all the variables which affect lead utilization.

The antagonism of sulfur and tetraethyllead has long been known, but the refiner's problems today are 1) how much sulfur can justifiably be removed on the basis of savings in tetraethyllead and 2) what process can best be used to remove this sulfur. The advent of large volumes of high-pressure hydrogen at relatively low cost as a by-product of catalytic reforming processes has altered the entire economic picture of sulfur removal.

Actually the over-all justification of sulfur removal at one point or another in the refinery is composed of a number of complex factors including:

1. **Decreased product odor**
2. **Decreased refinery corrosion**
3. **Lessened refinery operating problems**
4. **Improved color and lessened gum formation**
5. **Improved tetraethyllead response**
6. **Sale of recovered sulfur**
7. **Avoidance of catalyst poisoning**
8. **Improvement in lube-oil life in the engine**

Of these various factors, perhaps the easiest to assign dollars-and-cents justification to (and certainly the one with most widespread application) is a saving in tetraethyllead.

Figure 1 shows the effect of the type of sulfur compound on Research octane number loss. This plot is based on U.S. pool gasoline which has a 79.2 Research octane number clear and a 92.0 Research octane number with 3 cc. of lead, and which contains 0.075 per cent total sulfur which may take the

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

form of the various compounds shown below.

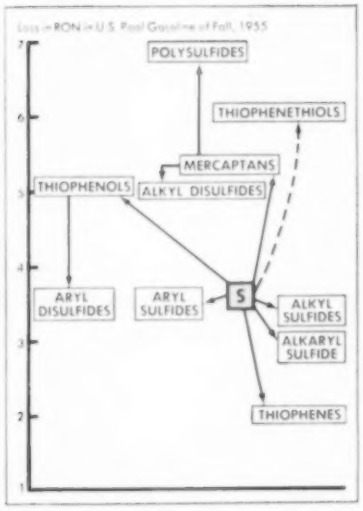


Fig. 1. *Effect of type of sulfur compound on RON loss*

Actually, a reasonable assumption would be that gasoline contains half monosulfide sulfur and half thiophenic sulfur. Complete removal of this sulfur, although economically attractive, is a practical impossibility. With the advent of hydrogen treating, however, there is no reason why 50%

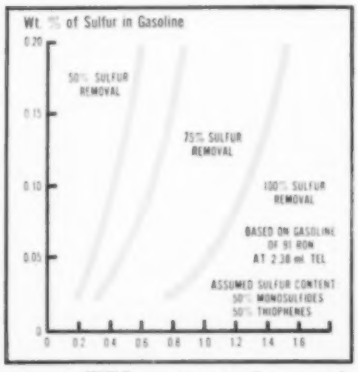

Wt. % of Sulfur in Gasoline
50% SULFUR REMOVAL
75% SULFUR REMOVAL
100% SULFUR REMOVAL
BASED ON GASOLINE OF 91 RON AT 2.38 ml. TEL
ASSUMED SULFUR CONTENT 50% MONOSULFIDES 50% THIOPHENES

Fig. 2. *TEL savings (ml. per gal.) with sulfur removal*

sulfur removal cannot become a reality. Figure 2 illustrates the TEL savings which are possible with 100%, 75% and 50% sulfur removal from U.S. pool gasoline of 91 RON with 2.38 ml. of TEL.

The average refiner, while he may be interested in the above data, still wants to know, "What's in it for me?" and Figure 3 answers this question. Here the possible savings in cents per barrel of gasoline are shown as a function of the weight per cent sulfur in the

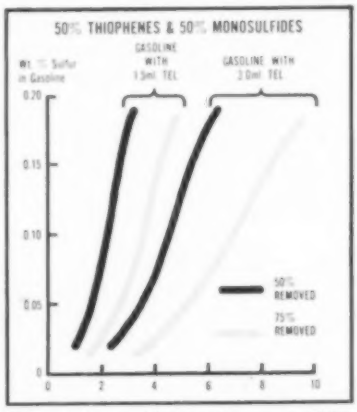


Fig. 3. *¢ per bbl. savings possible*

gasoline pool. This relationship is independent of the lead susceptibility of the particular stock and of the Research octane number level. Here, again, we are assuming half monosulfide sulfur and half thiophenic sulfur, and the economics of 50 and 75 per cent sulfur removal are shown for TEL levels of 1.5 and 3.0 ml/gallon.

For example, it can readily be seen that a pool gasoline requiring 3 ml/gal of TEL and containing 0.10% sulfur could meet the same octane specifications with a saving in TEL cost of 7 cents per barrel if 75% of the sulfur were removed.

It is not unreasonable to assume that pool octane number could be raised one unit by desulfurization. Current octane-improvement costs, as shown by recent Ethyl studies, range as high as 16 cents per Research octane number per barrel. Therefore, 16 cents per barrel could be considered a justifiable expenditure for desulfurization on the basis of Research octane quality alone. Your justification will depend on the conditions specific to your refinery.

The optimum operation of your refinery to permit you to make the most of your lead could be the subject of a profitable discussion with your Ethyl refinery technologist. Your Ethyl Representative will be glad to arrange an appointment for you.

What Ethyl Research offers you

At today's high octane level, the advantages of getting more efficiency from your lead have taken on more and more importance. To complement the intensive effort which the industry is devoting to this problem, Ethyl Research is continuously studying how the hydrocarbon blending and sulfur removal factors can lower lead requirements.

We are constantly testing and probing all the variables which affect lead utilization in today's high-compression engines. The problem of sulfur removal and the sudden entrance of high-pressure hydrogen, as a by-product of catalytic reforming, into the economic picture is being watched very carefully at Ethyl Research. Write to Ethyl Corporation, Box 12, for a copy of "Sulfur in Gasoline—an Economic Appraisal"—another in the continuing series of reports from the Ethyl Corporation on fuel blending and other studies of vital interest to refiners today.

For further information, just call your Ethyl Representative. He'll be happy to arrange an appointment for you with one of our Technical Representatives.

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RIPPLE TRAYS

Details of the latest in fractionating equipment: Higher capacity, insensitivity to load changes, and lower costs claimed

A New Tool for Vapor-Liquid Contacting

M. H. Hutchinson
and
R. F. Baddour*

Stone & Webster Engineering Corporation, Boston, Massachusetts

RIPPLE Trays (U. S. Pat. No. 2,767,-967) are made from sheet metal that is perforated in the flat and then bent into sinusoidal waves. One function of the waves is to act as predetermined discharge points for liquid, as it flows from the bottom of one tray onto the froth of the tray below, in counter-current contact with vapor. Besides forcing a liquid distribution, the waves help provide flexibility with respect to vapor and liquid loads on any given tray, and they supply a third-dimensional design variable by which desired load ranges can be accommodated. From a structural standpoint, the waves provide rigidity and permit the use of light gage sheet metal.

In the usual construction, Ripple Trays are composed of sections framed by vertical rims and of a width to permit their passing through an 18-in. manhole. (Fig. 2.) The sections are bolted together in the shell, and the complete tray is clamped to a narrow support ring. Up to a diameter of 9 ft, no beams are required. Access openings are provided for inspection. A modified construction, comprising one-piece trays with removable supports, is sometimes preferred. (Fig. 1.)

Fabrication in any structural metal is possible, although Type 410 stainless steel is most common. Carbon steel is not used because a positive safeguard against hole enlargement is desired and because too little saving would be effected in view of the low weight of material required.

Simple slotted distributor "boxes" are the usual means of introducing liquid above the top tray. In no cases have redistributors been required.

A number of standard Ripple Tray types have been developed to provide flexibility about most of the design conditions encountered. Special modifications of perforations and corrugations can be made to meet extreme or unusual requirements. For clean service, ⅛-in. holes are used, but larger holes are provided for fouling conditions. Total open area is usually within the range of 15 to 30 per cent of tower cross section. Wave depth is variable, depending upon design liquid loading. The shallowest depths are for low loadings, those under 500 gal per hr per sq ft, and the deepest are for high loadings, those over 2000.

*Assistant Professor of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts.

†Especially adapted by authors from a paper presented to the AIChE, Boston, Massachusetts meeting, December, 1956.

Operation and Flexibility

Ripple Tray towers are so rated that, for the design fluid rates and for a range of fluid rates and ratios above and below design, a bed of froth of predetermined height is supported on each tray. The froth appears very much like that on any well designed flat sieve tray, but there is a more pronounced turbulence which increases with increased rates. Froth depth is more subject to changes in liquid and vapor rates since an overflow weir is not used. Fig. 3 shows schematically the operation of superimposed trays. Froth height is usually about half the tray spacing for

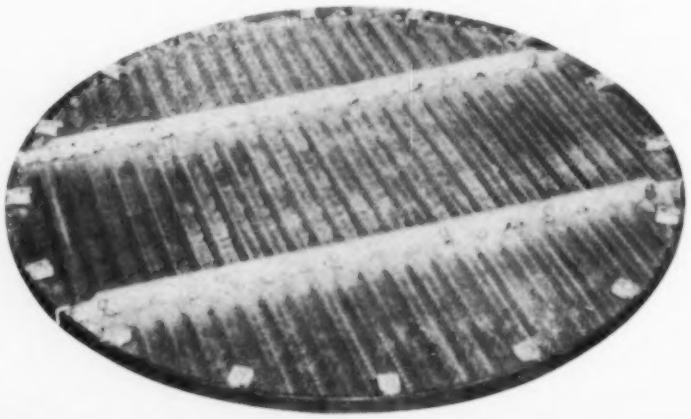


FIG. 1. Ripple Trays of one-piece construction. — Courtesy, Artisan Metal Products, Inc.

FIG. 2. Installation of a sectional tray.
— Courtesy, Artisan Metal Products, Inc.

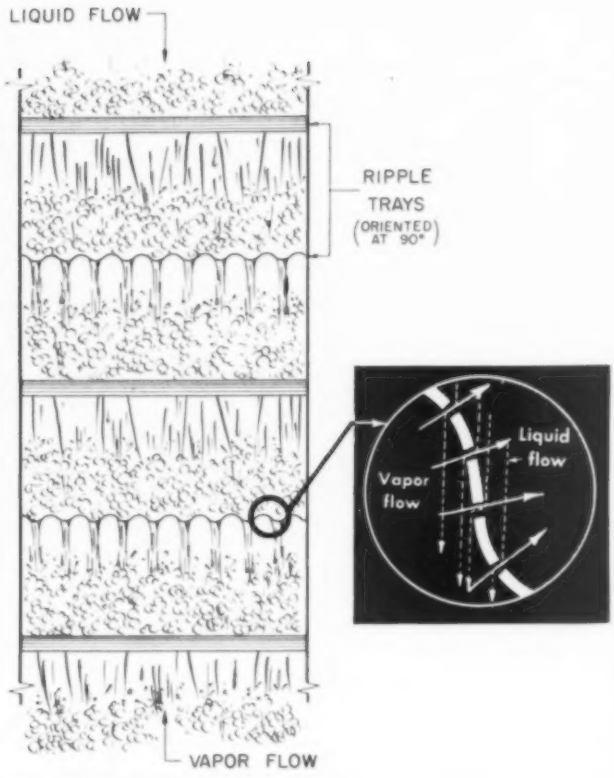


FIG. 3. Cross-section of the tray in operation.

design conditions, and is influenced by fluid properties as well as fluid rates and tray type. An increased understanding of the complex hydronamic situation is making it possible to predict froth heights with greater confidence. In general, it has been found that the froth may become as low as an inch or two or almost as high as the spacing between trays while functioning efficiently.

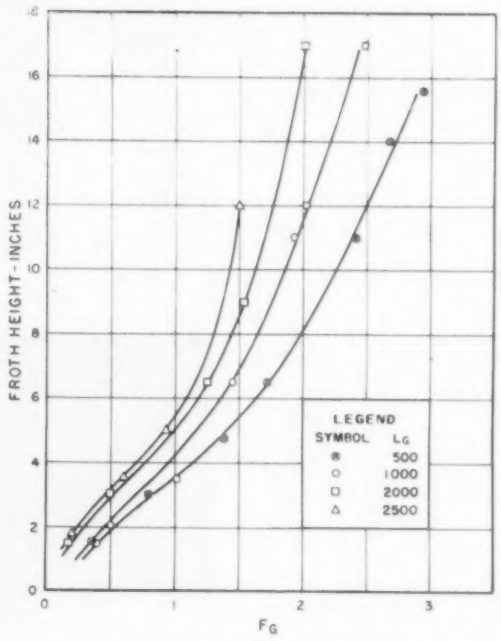
To visualize flexibility in terms of the above concept, reference may be made to Fig. 4a, which shows froth height as a function of liquid and vapor rates for a tray type suitable for moderate liquid loadings. These data were obtained in a 27-in. column with air and water at atmospheric conditions. Liquid rate is given as L_G, gallons per hour per square foot of tower cross-sectional area. For the purpose of using familiar terms, vapor rate has been expressed here as the tower factor, F_G, superficial velocity times the square root of vapor density, all in foot-pound-second units. As an example, for fluids properly represented by air and water, froth height would be 6¾ in. for a design L_G of 800 and a design F_G of 1.6. On the assumption that efficient operation is required up to 125 per cent of design rates, maximum froth height would be 11½ in., corresponding to an L_G of 1000 and an F_G of 2.0. By using 15-in. spacing, any load combinations should be accommodated which produce froth heights between about 2 and 12 in.

The operating flexibility, with respect to changing vapor and liquid rates, is due to the fact that the same openings may serve for either phase. Although vapor flow tends more toward the higher areas and liquid flow toward the lower, there is definite segregation. Furthermore, the smooth and gradual transition between high and low areas permits natural adjustments to accommodate changes in fluid rates. The turbulence which increases with the increase in rate of either fluid is a natural means for allowing the same total hole area to accommodate an increase in total flow.

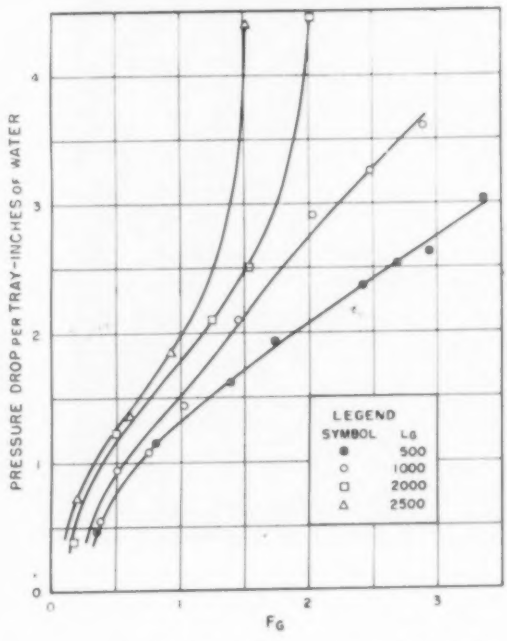
The self-cleaning feature of Ripple Trays results from the turbulence on a tray and the continual wetting and washing action on the bottom surface. This absence of relatively stagnant area is important, especially in services where coking is apt to be a problem. The self-cleaning feature was first recognized when fermentation mash was fed to a semiworks unit fitted with trays in which holes were ⅜ in., large enough to pass the largest solids. Instead of the gradual deposition of solids, which is an accepted condition with flat perforated trays, no plugging was observed after extended operation. Subsequently, Ripple Trays with ¼-in. holes were substituted for bubble-cap trays in a visbreaker flash tower for producing a clean distillate from tarry visbreaker heater effluent. Although bubble cap trays had coked almost solid after a few weeks of operation, the Ripple Trays remained entirely clean. The tray action has also proved effective in preventing the occurrence of solids in a styrene finishing column where a "popcorn" form of polymer had previously been a problem with 2-in. Raschig ring packing. In the two months that the trays have been in service, no sign of solid polymer has been observed.

Pressure Drop

Fig. 4b shows how pressure drop per tray varies with vapor and liquid loads with the same system for which froth height curves are shown in Fig. 4a. In general, for the same pressure drop, Ripple Tray columns can handle substantially higher liquid and vapor loads than can bubble-cap columns. For example, the design conditions chosen above correspond to 2.0 in. of water per tray. A typical bubble-cap tray, having an average of 6½-3in. caps per sq ft of tower cross section, and an average operating seal of 1¼ in. must operate at an F_G of 0.8 to give the same pressure drop, thereby requiring twice the tray area required by the Ripple Tray. Commercial installations on vac-



a. Variation of froth heights with loading.



b. Variation of pressure drop with loading.

FIG. 4. Operating characteristics of tray designed for moderate liquid loadings. 27-in. test column operating on air-water.

uum service have exhibited pressure drops as low as 1.5 mm of mercury per tray.

Efficiency Characteristics

Fig. 5 illustrates the uniformity of efficiency which can be experienced with Ripple Trays over a wide range of loadings. Murphree vapor efficiencies for stripping ethanol-water mixtures are represented as a function of F_G, with molal reflux ratio, O/V, as parameter. These data were obtained for the middle tray of an 18-in. diam semiworks column containing three trays at 18-in. spacing. The column was operated at 5 psi gage pressure, and a concentration of about 6 mole per cent ethanol was maintained in the liquid from the middle tray.

Most of the points at loads above the minimum for developing froth are seen to fall between 60 and 75 per cent. Within the experimental accuracy, the efficiency may be considered constant with respect to the load. The magnitude is comparable to that of point efficiencies of bubble-cap trays for the same system, a system in which mass transfer resistances are present in both liquid and vapor phases.

Commercial Applications

The extent and diversity of commercial scale applications are indicated by the following list of services, on which Ripple Trays are now operating or will soon be operating:

- Acetone recovery.
- Caustic scrubbing.
- Crude fractionation (pressure, atmospheric and vacuum).
- Ethanol water fractionation.
- Ether-ethanol fractionation.
- Ether finishing.
- Ethylene-ethane fractionation.
- Gasoline rerunning.
- Gasoline stabilization.
- Isopentane fractionation.
- Light hydrocarbon fractionation (straight run and cracked).
- Naphthalene purification.
- Phenol purification.
- Pine oil fractionation.
- Pyrolysis gas quenching.
- Styrene rerunning.
- Sulfur dioxide absorption.
- Tar separation.

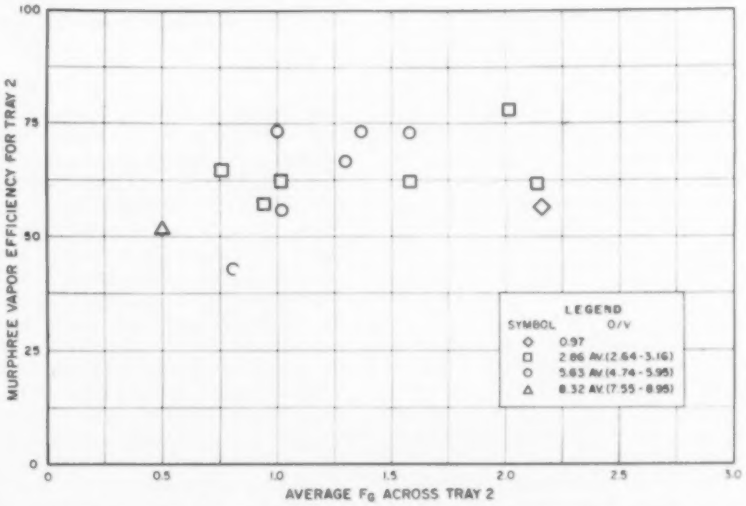


FIG. 5. Murphree vapor efficiency for tray 2. Ethanol-water, liquid composition leaving tray 2 about 6 mole percent.

P 721.92

Performance of Ripple Trays in commercial operations tends to substantiate the more systematic data obtained from the semiworks unit described above and from extensive laboratory tests. The use of many more trays and much larger trays has not been accompanied by maldistribution and the problems it can create. The distribution of liquid and vapor at the bottom of a 52-in. diam, 55-tray tower, has been excellent, as seen through a window during operation. The low surface tension of boiling liquids encourages good distribution, making it superior, in general, to that obtained with air and water.

Overall efficiencies of 80 to 90 per cent have been shown for the absorption of sulfur dioxide in sodium carbonate solution for the production of sulfite liquor. In the 42-in. diam tower used, L_G was 1200 to 1800, and F_G was 1.1 to 1.7, with 24-in. spacing and a high froth height. Based on previous practice, a packed tower having almost 10 times the Ripple Tray tower volume would have been required for the same service.

A 44-in. diam tower with 40 trays, operating on the recovery of pure naphthalene from a coal tar cut, has indicated an average overall efficiency of the order of 75 percent. With 11-in. tray spacing, F_G has run well above 2.0, while the corresponding L_G has been about 400. This tower has shown a high degree of flexibility and excellent distribution throughout.

One of the most recent applications of Ripple Trays is that enabling an oil refinery crude unit to operate above 150 per cent of its original design throughput. Preliminary operating data have shown no indication of towers limiting with a crude rate of 31,500 BPSD, a temporary maximum set of auxiliaries. The original design capacity with bubble-cap trays had been 20,000 BPSD. For the modification, Ripple Trays were installed in the same shells in all locations affected by loading, as shown in Table 1. Fractionation, in general, has been reported as comparable to that obtained with the bubble-cap installations.

TABLE 1—Ripple Tray Installations in Crude Distillation Unit.

Tower	Section	Diam. Ft-In.	No. Ripple Trays	Tray Spacing In.	Oper. Press.	Design Loads Corresponding to 30,000 BPSD: Max F_G	Design Loads Corresponding to 30,000 BPSD: Corres. L_G
Primary	Rectifying	5-0	10	24	40 psi gage	1.92	900
Atmospheric	Rectifying	9-6	25	30	Atmos.	2.20	493
Vacuum	Rectifying	13-6	6	30	Vacuum	1.67	360
Stabilizer	—	3-0	30	20	200 psi gage	1.15	2600
Visbreaker flash	—	2-6	2	12	45 psi gage	1.68	240

Notation

F_G = Gross tower factor, $u(\rho_r)^{1/2}$

u = Linear vapor velocity based on gross cross-sectional area of column, fps

ρ_r = Vapor density, lb per cu ft

L_G = Liquid rate based on gross cross-sectional area of column, gal per hr per sq ft

O/V = Molal ratio of liquid rate to vapor rate within the column

GASOLINE OCTANE NUMBER TRENDS IN NINE PRINCIPAL CITIES

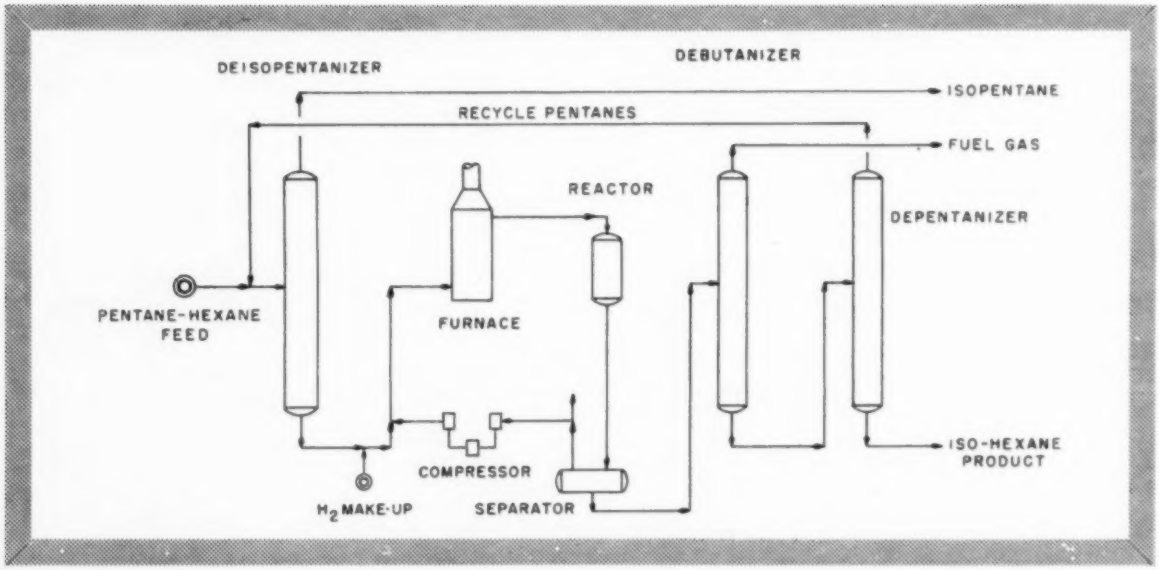
	PREMIUM			REGULAR		
	Motor	Res.	Tel, cc/gal	Motor	Res.	Tel, cc/gal
CHICAGO						
April, 1956	87.0	95.2	2.50	83.3	88.9	2.19
July, 1956	86.9	97.2	2.61	83.9	90.8	2.40
October, 1956	87.5	96.8	2.76	84.4	91.4	2.61
January, 1957	87.6	97.1	2.51	85.0	91.2	2.44
DENVER						
April, 1956	83.8	92.5	1.77	80.5	85.8	1.64
July, 1956	84.7	93.7	2.27	80.6	85.8	2.01
October, 1956	84.4	93.8	2.23	80.4	85.6	1.88
January, 1957	84.4	93.7	1.92	81.0	86.2	1.60
DETROIT						
April, 1956	86.6	95.9	2.33	83.7	90.7	1.96
July, 1956	86.8	96.8	2.67	84.1	91.3	2.46
October, 1956	87.4	96.7	2.56	84.5	91.6	2.32
January, 1957	87.8	97.4	2.26	84.8	91.5	2.00
HOUSTON						
April, 1956	87.2	97.5	2.81	83.8	89.0	2.70
July, 1956	87.0	97.4	2.69	82.9	89.2	2.18
October, 1956	87.2	98.0	2.66	83.3	89.6	2.30
January, 1957	88.0	98.1	2.59	84.0	89.4	1.78
LOS ANGELES						
April, 1956	85.0	96.0	2.55	79.2	86.1	1.36
July, 1956	85.0	96.5	2.66	78.9	86.1	1.67
October, 1956	85.5	96.4	2.56	78.7	86.0	1.43
January, 1957	85.3	96.5	2.35	79.0	86.6	1.22
METRO. NEW YORK						
April, 1956	86.8	96.7	2.67	84.9	92.0	2.57
July, 1956	86.8	97.3	2.65	84.7	91.5	2.63
October, 1956	87.7	97.7	2.70	84.8	91.9	2.57
January, 1957	87.2	97.8	2.38	85.2	92.6	2.02
PHILADELPHIA						
April, 1956	86.7	96.4	2.27	84.5	91.6	2.37
July, 1956	86.5	96.9	2.24	84.4	91.9	2.17
October, 1956	86.9	97.3	2.54	84.3	91.8	2.43
January, 1957	87.5	97.4	2.33	85.0	92.5	2.19
SAN FRANCISCO						
April, 1956	86.4	96.6	2.57	80.8	86.4	1.40
July, 1956	85.9	96.7	2.54	80.6	86.7	1.83
October, 1956	85.9	96.7	2.61	80.2	87.0	1.64
January, 1957	86.0	96.8	2.23	80.8	87.2	1.43
TULSA-OKLAHOMA CITY						
April, 1956	86.4	94.6	2.49	82.6	86.6	2.11
July, 1956	86.5	96.3	2.64	83.3	88.4	2.62
October, 1956	86.1	95.8	2.53	82.7	88.5	2.22
January, 1957	86.7	96.1	2.41	83.2	87.9	1.97

DuPONT QUARTERLY OCTANE NUMBER SURVEY SHOWS SOME INCREASES, MOSTLY IN REGULAR GRADES . . .

Premium grade gasolines registered only slight Research octane gains during the past three months, Detroit showing the greatest, 0.7 CFRR. On the longer pull from April, 1956, to January, 1957, Research octane is decidedly higher, up 0.2-1.9 octane numbers, with Chicago leading the pack. Significant gains are shown for motor octane of premium gasolines, up 0.3-1.8 points.

Regular grade gasoline is up markedly, ranging from 0.4-2.3 CFRR during the past nine months. Commensurately, motor octane of regular is also on the climb, increasing 1.7 units in Chicago.

Paradoxically, TEL usage is down in many instances. Apparently, the rash of construction of cat reformers and other octane improvement process units has more than satisfied octane demand . . . for the time being, at least . . . with lead dosage reduced. But, lead usage will probably go up before it goes down again . . . if it ever does.



Newest Pentane-Hexane Isomerization Process

"Iso-Kel" is the newest entry in the isomerization parade

M. W. KELLOG COMPANY recently announced a new process, ISO-KEL, for isomerization of light naphthas. It is designed to upgrade combined streams of pentane and hexane to higher-octane number isomers, is equally adaptable in refineries and natural gasoline plants. The octane boost potentially available from isomerization is readily seen from the data in Table 1, which shows the Research octane numbers of the pentane and hexane isomers.

The process is based on a new precious metal catalyst (not platinum) that was developed by Kellogg. It is a vapor-phase process with only one reactor—which operates in the presence of hydrogen. While specific operating details have not been revealed, it is stated that there are no corrosive elements in the system and operating conditions are less severe than those for reforming heavy naphtha.

TABLE 1—Octane Number of C_5 and C_6 Saturates

	Research Octane Number*	
	Clear	+3cc TEL
n-pentane	61.7	88.7
i-pentane	92.3	105.7
n-hexane	24.8	65.3
2 methylpentane	73.4	93.1
3 methylpentane	74.5	93.4
2,2 dimethylbutane	91.8	104.3
2,3 dimethylbutane	102.7	108.9

*Octane numbers above 100 by formula: $ON = 128 - \frac{2800}{PN}$

If desired, the product can be fractioned to produce two separate products: (1) An isopentane stream of 104.9 CFRR @ 3 cc TEL and (2) an isohexane stream of 89-92 CFRR @ 3 cc TEL, the latter depending upon the feedstock. The isopentane stream could, of course, be used for premium while the isohexane stream could be used for regular grade gasoline.

Yields are claimed to be 97 Vol per cent at an overall octane of 96 CFRR @ 3 cc TEL when charging light naphtha. When feeding natural gasoline, overall yield is reported to be 99 Vol per cent and octane number about 99.8 CFRR @ 3 cc TEL. Yields and qualities calculated for processing three light naphthas from varying crude sources are shown in Table 2; the calculations were based on experimental data obtained from processing pentanes and hexanes.

Processing Scheme

Depending upon feedstock quality and the octane increase desired, process flow can be varied to allow for prefractionation of isomers in the feed, and recycle of unconverted product. Kellogg's figures indicate that, in general, it is preferable to process pentanes on a recycle basis and to process hexane once-through.

Mixed feed is charged to a deisopentanizer, where it is joined by pentane isomerization product. The isopentane in both the fresh feed and product is taken overhead; the bottoms are charged to the reactor. Hydrogen-rich gas is charged to the reactor along with the feed and separated from the effluent for recycle. Nearly self-sufficient for hydrogen, only a small amount is required for make-up.

Product from the effluent separator is debutanized and depentanized. Bottoms from the depentanizer constitute, of course, the isohexane product. A variation on the theme for greater upgrading would be the addition of a deisohexanizer and an auxiliary depentanizer, to remove isomeric hexanes in

the feed or to give complete recycle of n-hexane.

Economics

Kellogg claims that, in the instance of a 50,000 bbl per day refinery, that a 3100 bbl per day Iso-Kel unit would show a payout of about 19 months . . . on a grassroots basis. Also, it is claimed that isomerization of hexanes involves only a small incremental investment over pentane isomerization alone. No further information on investment and operating costs were given.

Other Isomerization Processes

Iso-Kel is the third catalytic isomerization process to be announced within the past year. The others include:

- **Penex** . . . Universal Oil Product Company's process, separate reactors are used for pentanes and hexanes. A platinum catalyst is used along with hydrogen recycle.
- **Pentafining** . . . Atlantic Refining Company's process uses a regenerative catalyst to upgrade pentane, hexane, or heptane, either separately or in mixture. As with Penex and Iso-Kel, the reaction is carried out in the presence of hydrogen.
- Also in the lineup is the **Isomate** process, developed in the early 1940's by Standard of Indiana for processing hexanes and mixed pentane-hexane streams, an aluminum chloride-hydrocarbon complex (promoted with anhydrous HCl catalyst is employed. ★ ★ ★

TABLE 2—Predicted Yields and Qualities for Iso-Kel Isomerization

	KUWAIT		MID-CONTINENT		NAT GASOLINE	
	Feed	Product	Feed	Product	Feed	Product
TOTAL C_5-C_6						
Vol %	100.0	97.3	100.0	96.7	100.0	99.2
Octane CFRR-Clear	63.7	77.7	62.1	77.0	72.3	83.3
+3cc TEL	88.3	96.2	87.3	95.8	93.9	99.8
PENTANE FRACTION						
Vol % of Total C_5-C_6	45.0	45.0	34.5	34.5	58.5	58.5
Octane CFRR-Clear	74.4	91.0	72.9	91.0	79.2	91.0
+3cc TEL	95.8	104.9	94.9	104.9	98.4	104.9
HEXANE FRACTION						
Vol % of Total C_5-C_6	55.0	52.3	65.5	62.2	41.5	40.7
Octane CFRR-Clear	54.9	66.3	56.4	69.2	62.2	72.2
+3cc TEL	82.2	88.7	83.3	90.7	87.6	92.4

CAMPUS REFINERY . . .

. . . Students at Virginia Polytechnic Institute erected this distillation tower next to the chemical engineering building on the Blacksburg, Virginia, campus. The surplus tower and its attendant facilities were a gift from the Baltimore and Baton Rouge refineries of Esso Standard Oil Company.

Bogged with Smog

Another 10 years of auto exhaust smog? Lauren B. Hitchcock, president and managing director of the Air Pollution Foundation, has predicted that "not before 1966 can we see any relief from our number one source of smog — the motor vehicle exhaust." He felt that the sporadic inventions and data gathering thus far accomplished are only the usual reconnaissance preliminary to valuable development. He went on to say "it will take at least six years for development (of control devices) and three years for mass production and installation." A seven-point program for reducing organic compounds and nitrogen oxides in motor vehicle exhaust was proposed:

(1) After burners for all motor vehicles. (2) Catalytic converters for organic compounds on passenger cars and perhaps larger automotive engines. (3) Catalytic or other converters for nitrogen oxides on all motor vehicles. (4) Combination catalytic converters for both organic compounds and nitrogen oxides. (5) An induction-system device which may supplement any one of the foregoing. And in the more speculative field, (6) Combustion catalysts as fuel additives. (7) Modified or special fuels not relying on minor additives.

Hitchcock went on to advise that a joint council on motor vehicle exhaust should be formed to integrate efforts on a motor vehicle exhaust control program. He proposed that a committee be formed from the automobile industry, the oil industry, the air pollution control district, and the air pollution foundation, together with such technical assistance as the council might require. ★ ★ ★

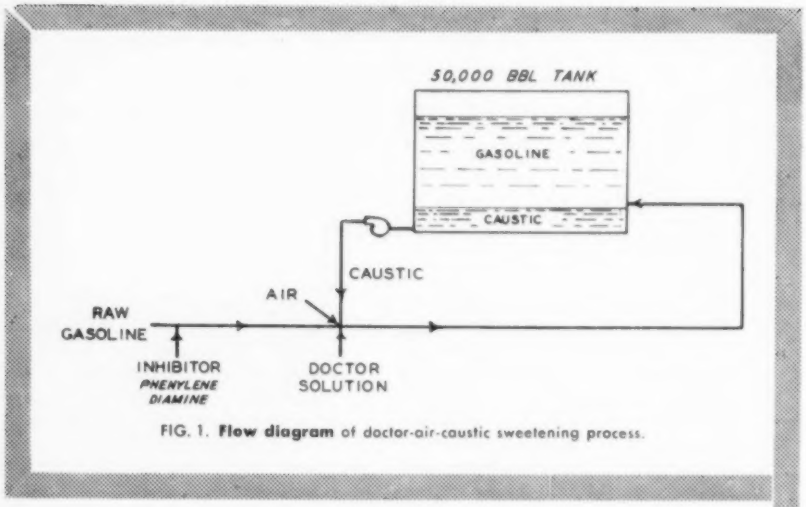


FIG. 1. **Flow diagram** of doctor-air-caustic sweetening process.

Addition of a small quantity of Doctor Solution speeds sweetening, cuts copper dish gum content, reduces TEL requirements

L. D. Rampino and M. J. Gorham
Tidewater Oil Company, Associated, California

Doctor-Air-Caustic Sweetening of Inhibited Gasoline

RESEARCH has led to even more improvement in the widely accepted air-caustic sweetening process. It has been found that the speed of sweetening light catalytic naphtha can be accelerated and the quality of the gasoline considerably improved if a small amount of doctor solution is injected into the caustic which is used during inhibitor sweetening. Also, inhibitor and tetraethyl lead consumption is reduced.

In the inhibitor sweetening process a sour cracked gasoline is first inhibited with phenylene diamine inhibitor and then contacted with air and caustic. After storage of the gasoline for a variable period of time the mercaptan odor disappears and the gasoline is sweet. Time of sweetening can be long or short depending on the type of gasoline, the amount and type of mercaptans, and the way the process is conducted.

The main disadvantage of inhibitor sweetening is this: As sweetening takes place peroxides are formed in the gasoline.[1] These peroxides lead to increased gum and lowered engine cleanliness. As a result, only certain types of gasoline can be satisfactorily sweetened by this process; in addition, end point of the gasoline must be controlled to prevent excessive gum formation.

Fig. 1 shows a schematic flow of plant operation. Light catalytic gasoline about 110/285 F boiling range is inhibited immediately after production, before contact with air, with 7.5 lb of phenylene diamine type of inhibitor per 1000 bbl; the gasoline is then treated with a mixture of caustic, doctor solution, and air; this mixture then flows to the run-down tank. In this scheme caustic is withdrawn continuously from the bottom of the tank and recirculated.

Laboratory work. Laboratory sweetening experiments were performed on line samples of the gasoline-caustic mixture taken just before entry into the tank. The mixture was stored in a brown glass quart bottle capped with a slotted cork to allow access to air.

Table 1 shows tests on the gasoline before and after the start-up of doctor injection.

The sweet gasoline had a much lower peroxide number and copper dish gum after the start-up of doctor injection. Blended copper dish gum was measured on a blend containing 50 vol per cent of the gasoline and 50 vol per cent of a light aromatic solvent containing 55 per cent aromatics and having a boiling range of 220 to 305F; this blend shows a much higher copper dish gum than the gasoline itself and was used because it magnified differences in gasoline quality.

TABLE 1—Effect of Doctor Solution on Laboratory Sweetening of Line Samples of Gasoline—Caustic Mixture.

Mercaptan sulfur of raw gasoline	0.0031 gms per 100 cc	
	Before Doctor Injection	After Doctor Injection
Tests on sweet gasoline		
Peroxide number	1.0	0.08
Blended copper dish gum	30	2

In the commercial experiment the amount of doctor solution injected corresponded to 1 per cent of the theoretical amount needed to react with all the mercaptans originally present in the gasoline.

The data in Table 1 were obtained on gasoline sweetened over the caustic. We were also interested in determining the effect of sweetening in absence of caustic. To do this a line sample of the gasoline-caustic-doctor-air mixture was allowed to settle and a portion of the clear gasoline was stored in absence of caustic; the remaining portion was allowed to sweeten in the presence of the caustic as sampled.

[1] Rampino, L. D. and Gorham, M. J., *Petroleum Processing* 10, 1146 (1955).

Table 2 compares the effect of conducting sweetening in the absence and presence of caustic.

TABLE 2—Laboratory Sweetening of Light Catalytic Gasoline in Absence and Presence of Refinery Caustic.

Mercaptan sulfur of raw gasoline: 0.0031 gms per 100 cc

Line Sample Before Entry into Tank

Mercaptan sulfur gms/100 cc	0.00094
Peroxide number	0.08
Blended copper dish gum	1

After Storage for 2 days

	Absence of Caustic	Presence of Doctor-Caustic
Modified doctor test	sour	sweet
Peroxide number	0.67	0.08
Blended copper dish gum	60	2

It is evident that the gasoline had a low peroxide number before it entered the storage tank. It is also evident that when the clear gasoline was allowed to sweeten in absence of caustic, peroxide number and copper dish increased considerably.

These data suggest that once the gasoline-caustic mixture enters the run-down tank and separates into two phases sweetening leads to lowered product quality. The implication is clear:

For optimum product quality a gasoline must be kept in contact with the caustic-doctor-air mixture until sweetening is complete.

Modified doctor test. This test, used for determining sweetness (Table 2), was developed because the conventional doctor test proved to be unsuitable for gasolines containing peroxides.

The conventional doctor test is performed in two steps: Sour gasoline and doctor solution are first shaken together to form lead mercaptides; sulfur is then added and the mixture reshaken to convert lead mercaptide to lead sulfide. Absence of an orange discoloration at the interface between gasoline and doctor solution is supposed to indicate that the mercaptan content is extremely low.

Peroxides interfere with this test by destroying lead mercaptide; as a result, formation of lead sulfide cannot take place when the gasoline is shaken with sulfur. This means that a gasoline containing peroxide can give a sweet doctor test even though a considerable amount of mercaptans are present.

To overcome the interfering effect of peroxides the doctor test is performed in one step: Gasoline, doctor solution, and sulfur are shaken together all at one time. The lead mercaptides formed in the presence of sulfur immediately react with the sulfur and peroxides do not interfere to any appreciable extent.

For example, using the modified doctor test a sour reaction is obtained at a mercaptan sulfur content as low as 0.0002 gms per 100 cc, even when the peroxide number of the gasoline is about 0.4. With the conventional doctor test, however, a gasoline with a peroxide number of one will give a sweet test at a mercaptan sulfur content two and one half times higher, that is, about 0.0005 gms per 100 cc. If peroxide content is high enough, even a gasoline with a bad odor will give a sweet test.

Commercial data. The data presented so far were obtained on samples taken in the refinery and allowed to sweeten in the laboratory. In commercial practice, of course, sweetening is completed in a large tank.

To simplify commercial operation two tanks were used alternately: The gasoline-caustic mixture was continuously pumped into one 55,000 bbl tank until this was full; the gasoline-caustic mixture was then diverted to a second 55,000 bbl tank while the first tank was being emptied of sweet gasoline.

Fig. 2 shows the data obtained over almost a three-week period on samples of the gasoline taken from both tanks while these were being filled and emptied. Mercaptan sulfur of the light catalytic naphtha used in this work ranged from 0.003 to 0.007 gms per 100 cc; boiling range was almost 110 to 285F.

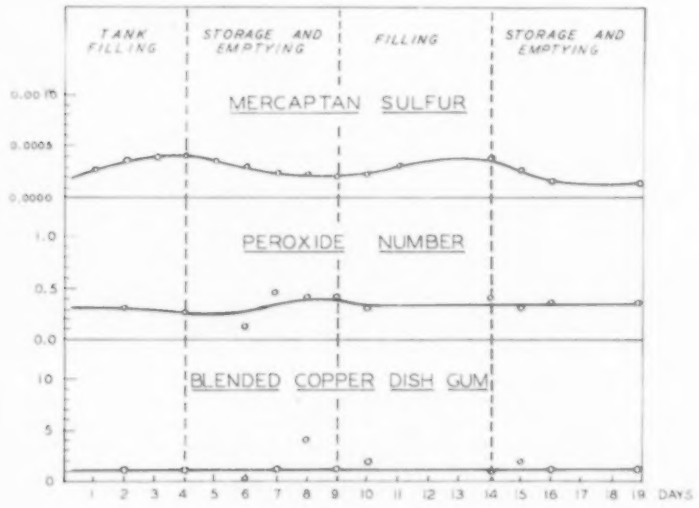


FIG. 2. **Analyses** of tank samples of treated gasoline.

It can be seen that speed of sweetening was very rapid— tank samples were usually doctor-sweet even though sour gasoline was being continuously pumped into the tank at the time of sampling; in those cases where tank samples were not doctor-sweet (usually on the last day of filling) storage for one day (with no sour gasoline pumped into the tank) was sufficient to produce a sweet gasoline.

More recent data show that the gasoline in the tanks is always sweet — mercaptan sulfur contents are usually less than 0.0001 gms per 100 cc. This means that less storage space is required for sweetening.

What is more significant, however, is this: The gasoline, *after sweetening*, has a very low peroxide number and copper dish gum; doctor injection thus achieves what had heretofore been impossible using conventional inhibitor sweetening.

In fact, before any improvements were made in sweetening, that is, when we depended on dissolved oxygen and carry-over caustic in the gasoline for sweetening, peroxide numbers of 1.5 to 2.0 were the rule and copper dish gums of 100 to 200 were not unusual; in addition, sweetening time was sometimes as long as two weeks. End point of the gasoline had to be lowered because of poorer quality.

Effect of raising end point of gasoline. After it was found that sweet gasolines of low peroxide number and copper dish gum could be obtained in the refinery, the end point of the gasoline was increased. This increase led to increased peroxide number and copper dish gum; however, when a line sample of doctor-air-caustic-gasoline mixture (containing identical gasoline) was allowed to sweeten *in the laboratory*, peroxide number and copper dish gum after sweetening were no higher than that of lower end point gasoline. This means that the way the sweetening process is conducted is more important than end point in determining product quality.

A major difference between refinery sweetening and laboratory sweetening is: In the refinery a column of gasoline as high as 40 ft is stored over caustic; in the laboratory the height of the gasoline layer above the caustic was only five inches. Thus there is better contact between gasoline and caustic in laboratory experiments.

Inhibitor disappearance. A small

amount of data were obtained on the change in inhibitor content of tank samples of gasoline after sweetening. These data show, in some cases, hardly any reduction in inhibitor concentration after sweetening and in some cases, a loss of a few pounds of inhibitor per 1000 bbl of gasoline.

Reduced Inhibitor Costs

As mentioned previously, conventional inhibitor sweetening leads to high peroxide numbers and high copper dish gum. For those refiners who have a copper dish gum specification on their finished gasoline and require extra inhibitor to reduce copper dish gum, the improved process for sweetening can lead to substantial savings through reduced inhibitor usage.

Reduced Usage of Tetraethyl Lead

It has been found that the octane number of premium gasolines containing reformates is lowered by the presence of peroxides.

Table 3 shows octane numbers of a premium gasoline containing light catalytic gasoline of different peroxide content. The blend tested contained 50 per cent reformate, 30 per cent light catalytic gasoline, and 20 per cent of natural gasoline. In one case the light catalytic gasoline had a peroxide number of 0.33 after sweetening over caustic containing a small amount of doctor solution; in the other case, the same light catalytic gasoline, sweetened over caustic containing no doctor solution, had a peroxide number of 1.3.

The Research octane numbers of the blend containing low-peroxide-content light catalytic gasoline were 0.5-0.7 units higher than the blend with the higher peroxide content. The amount of TEL required to meet a 94.5 Research octane specification was 1.49 cc for the higher peroxide blend and 1.23 cc for the low peroxide blend, a difference of 0.26 cc per gal. This difference increases as the octane number is raised, amounting to 0.46 cc at 96.0 Research octane number. At 96.0 Research octane number, the savings in TEL usage amount to $41,600 for every 1,000,000 gal of the gasoline blend shown in Table 3.

TABLE 3—Octane Numbers of a Premium Gasoline Containing Light Cat Gasoline of Different Peroxide Content.

Blend	Peroxide No.	Peroxide No.
50% Platformate (4-21)	0.15	0.15
30% Lt. Cat.	1.30	0.33
20% Natural	0.00	0.00
Final Blend	0.49	0.16
Octane Numbers		
Res. Clear	89.0	89.5
Res. + 3.0 TEL	96.8	97.5
Motor Clear	80.2	80.3
Motor + 3.0 TEL	87.6	88.0
TEL for 94.5 RON	1.49 cc	1.23 cc Difference: 0.26 cc/gal
TEL for 96.0 RON	2.34 cc	1.88 cc Difference: 0.46 cc/gal

Savings In TEL — $41,600 for every million gallons of blend.

Conclusions

Injection of doctor solution into caustic improves the process for inhibitor sweetening light catalytic naphtha: Speed of sweetening is faster, peroxide content of the sweet gasoline is lower, and product quality is improved.

For excellent product quality, sweetening must be conducted in the presence of caustic.

Substantial savings can be realized through decreased inhibitor and tetraethyl lead usage. ★ ★ ★

The Authors

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Dr. L. D. Rampino is a senior research chemist and group leader (gasoline and catalysts) with Tidewater Oil Company's R & D Department, Associated, California. Armed with a BS and MS in chemistry from Canisius College and a PhD in chemistry from Fordham University, Rampino started his career in 1941 as a research associate in the Manhattan Project. A native of upstate New York, he decided to head for warmer climes when he joined Shell Development Company as a group leader in Emeryville, California, in 1943. In 1946 he set up shop as a chemical consultant in Los Angeles, assuming his present duties in 1948. Married, he has three children, two boys and a girl, that serve to fill his spare time. Dr. Rampino is a member of the ACS, the American Institute of Chemists, and Sigma Xi.

Co-author Milton J. Gorham is another Californian by choice, having settled there in 1946 following a two-year tour of duty with the Navy. Originally from Minnesota, Gorham received an AS in Chemical Engineering from Virginia Junior College, Virginia, Minnesota, in 1941, and a Bachelor of Chemistry degree from the University of Minnesota in 1943. The Navy called him to the colors after a year with Sharples Chemicals, Wyandotte, Michigan. All of his time in California has been spent with Tidewater Oil Company, starting as a junior research chemist in 1946. A series of promotions have lead to his present position, that of senior research chemist, in Tidewater's R & D Department, at Associated, California. He and Mrs. Gorham have three children . . . two boys and a girl. Outside activities include the Naval Reserve and ACS.

Automatic Data Logger and Computer . . . to be installed at the Belot Refinery of Esso Standard S.A. near Havana, Cuba, this unit will calculate 11 basic operating guides along with logging 101 critical operating variables. To assist process engineers in selecting optimum operating conditions for the plant's Model IV Fluid Catalytic Cracker, the unit will "print out" hourly, more frequently if desired. Also, major process variables derived from the machine will be automatically totalized and recorded every 24 hours.

LPG Industry Review For 1956

Sales in 1956 up one billion gallons, greatest increase on record. 1957 outlook is excellent. Phillips' staff reviews all facets of the industry.

George R. Benz, Paul W. Tucker, and W. F. Devoe

Phillips Petroleum Company, Bartlesville, Oklahoma

FIG. 1 — New LP-LPG gas production facilities under construction.

LPG sales in 1956 appear to have increased by a record breaking 1,001,000,000 gal, sending total sales to an estimated 6,997,000,000 gal. This is a 16.7 per cent increase over 1955 total sales. Increases are especially impressive in chemical, motor fuel, and house heating. New applications continue with production, storage and transportation facilities keeping pace with ever increasing demand. Another record year is seen in 1957.

Domestic and motor fuel. The combined domestic and motor fuel market for LPG in 1956 is estimated at 4,068,000,000 gal which is an increase of 615,000,000 gal or 17.8 per cent over 1955. House heating, still the largest single factor in the domestic growth, continues to move north as more people become familiar with and are sold on the convenience of gas. The expansion and extension of natural gas lines into new areas causes more people to become "gas conscious." LPG is popular in new housing developments and central heating is becoming more widespread in new home building and remodeling programs.

Tank lease or loan programs have increased domestic demand tremendously in some areas — but these programs also greatly increase the capital which the distributor must have.

The use of LPG for crop dehydration and similar uses continued to grow in spite of the drought in the Southwest. In some cases the drought has actually increased the use of LPG, for example, spine burning of "prickly pears" to make them edible for cattle. This is a growing market for LPG in the far Southwest and will probably continue even when the drought breaks. Flame weeding with LPG increased in 1956. LPG is becoming well established as the best fuel for tar and asphalt kettles, plumber's pots, wallpaper steamers, etc.

Motor fuel. It is estimated that almost 850,000,000 gal of LPG were used as motor fuel in internal combustion engines in 1956. This is a 30 per cent increase over 1955 and represents approximately 12 per cent of total industry sales. Motor fuel sales were up significantly in nearly all parts of the country with the biggest users being trucks, buses, tractors, industrial trucks, irrigation and drilling engines.

Reports indicate that an estimated 2000 LPG fueled buses were in use at the beginning of 1956 and that 250 factory-equipped LPG buses were ordered for delivery in 1956 and early 1957. It is estimated that buses alone consumed 30,000,000 gal in 1956.

It is estimated that there were 12,200 LPG tractors produced in 1956, representing 5 per cent of total tractor production (gasoline tractors constituted about 82 per cent and diesel tractors 13 per cent of total production). It is significant to note that while 1956 LPG tractor production has increased from 11,778 to 12,220 (about a 4.5 per cent increase), total tractor production has decreased from 330,776 in 1955 to 246,500 in 1956 or a decrease of over 25 per cent. Gasoline tractors decreased about 27 per cent and diesel tractors decreased about 24 per cent. There were over 45,000 tractors converted to LPG in 1956, which is about 7 per cent less than in 1955. There are now about 303,000 LPG farm tractors, representing 6.4 per cent of the total tractor population. Farm tractors, irri-

Record Sales for LPG in 1956.

Domestic and motor fuel	Up	17.8%	to	4,068,000,000 gal
Industrial and miscellaneous	Up	10.4%	to	614,000,000 gal
Gas manufacturing	Up	9.5%	to	234,000,000 gal
Chemical manufacturing	Up	20.1%	to	1,642,000,000 gal
Synthetic rubber	Up	8.1%	to	439,000,000 gal
Summing up	Up	16.7%	to	6,997,000,000 gal

FIG. 3 — The large single barrel transport being loaded at an LP-LPG gas terminal.

FIG. 2 — LP-LPG gas fueled lift trucks continue rapid growth.

gation engines and drilling rigs represent about 75 per cent of the LPG used as a motor fuel.

Lift trucks and cargo refrigeration units still represent the fastest growing motor fuel market.

Truck conversion continues to increase but at a slower pace. More LPG service stations are becoming available to take care of this market. LPG fueled road rollers, garbage trucks and "ready mix" concrete trucks are becoming very popular.

The industry is still in real need of truck engines properly designed to fully utilize the inherent advantages of LPG. To date only one truck manufacturer has built truck engines specifically for LPG and performance of these engines has been almost spectacular. The others are still using gasoline engines with minor modifications.

It appears that all truck manufacturers should deliver an engine built specifically for LPG in order to remain fully competitive in the fast growing LPG fueled truck market.

Appliances. Sales of major heating appliances were generally up in 1956. Range sales were down 3.9 per cent. Automatic LPG water heater sales are estimated at almost 350,000 — the same as 1955. Sales of warm air furnaces are estimated at 78,000 — up about 8 per cent over 1955. Sales of direct heaters and recessed wall heaters are estimated at 496,100. Floor furnace sales were down by 18 per cent to 32,500 in 1956.

The increase in tank sales is estimated as up over 15 per cent with 500 and 1000 gal aboveground tanks showing the largest increases.

Industrial and miscellaneous. LPG for industrial and miscellaneous uses are estimated at 614,000,000 gal which is an increase of 10.4 per cent or 58,000,000 gal. Part of this increase is due to the inclusion of refinery fuel gases containing LPG in this category. The continued increase in business activity, plus new uses kept the demand for LPG as an industrial fuel on the upswing. The addition of standby plants continues as protection against winter shutdowns. The actual demand for this portion of the industrial load is determined by the severity of the weather. Asphalt aggregate drying is a relatively new industrial application and should expand rapidly with highway construction expanding due to the increased Federal aid program.

Gas manufacturing. The utility use of LPG maintained its upward swing with an estimated total of 234,000,000 gal or a 9.5 per cent increase over 1955. One new refrigerated storage installation for utility use was completed and much interest is being shown in underground storage by utilities for peak shaving. Interest is shown also in reforming LPG for utility gas purposes. Again, cold weather is the primary determining use factor. The joint gas promotion (gas utility companies and LPG companies) took a big step forward by the formation of the Gas Unity Committee.

Chemical manufacture. Although the steel strike delayed the construction of numerous petrochemical plants, the sales of LPG as a raw material for the manufacture of chemicals and chemical intermediates continued to gain at a high rate. It is estimated that the increase over 1955 was 20.1 per cent, making the total volume 1,642,000,000 gal so used during 1956. As in 1955, the increase was sparked by the growing demand for polyethylene, and the large number of polyethylene plants now under construction assures another substantial gain for 1957. In addition to polyethylene, interest in other polyolefins (polypropylene, polybutylenes and polybutadiene) is high.

Despite the drop in automobile production, demand for synthetic rubber expanded, and new butadiene and styrene plants are being built and existing units expanded. Since butadiene is a promising chemical intermediate it is expected that a large volume will be used in other than the manufacture of synthetic rubber.

Large volumes of LPG were used in the production of phenols, acetones, glycols, amines, detergents, additives, alcohols, and many other oxygenated hydrocarbons. The production of nitroparaffins and their derivatives continued to increase.

This category now includes gas and liquid streams containing methane and ethane plus LPG. These streams have not been considered as LPG in the past and would not meet specifications for the "domestic" LPG market. Use of these streams as petrochemical plant feed stocks increased at a rapid rate

TABLE 2—Marketed Production of LPG.*

Year	Gallons (in thou.)	% Increase	Domestic & Motor fuel	% Increase	Industrial Misc. (1)	% Increase	Gas ndg.	% Increase	Chemical Mfg	% Increase	Rubber Components	% Increase
1930	18,017	81 4	11,800	100 0	2,200	46 7	4,000	60 0	—		—	
1935	76,855	36 2	21,380	20 9	47,894	47 6	7,581	20 4	—		—	
1940	313,456	40 2	134,018	53 1	124,482	32 8	20,285	31 4	34,671	29 0	—	
1945	1,276,766	20 4	533,262	19 7	256,577	0 8	53,849	17 4	224,291	47 5	208,787	28 8
1950	3,482,567	22 8	2,022,464	24 3	355,456	(3)	251,694	5 2	624,468	14 6	228,485	28 5
1951	4,227,275	21 4	2,456,804	21 6	269,408	(3)	281,692	11 9	844,507	35 2	374,864	64 1
1952	4,477,379	5 9	2,636,736	7 4	338,959	26 0	259,697	—7 8	870,990	3 1	370,997	—1 1
1953	4,932,009	10 2	2,977,418	12 9	374,233	1 04	222,430	—14 4	967,427	11 1	390,501	5 3
1954	5,125,533	3 9	3,174,012	6 6	401,615	7 3	191,932	—13 7	1,050,239	8 6	307,735	—21 2
1955	5,996,483	17 0	3,453,200	8 8	556,371(3)	38 5	213,760	11 4	1,366,942(5)	30 2	406,210	32 0
Est. 1956.	6,997,000	16 7	4,068,000	17 8	614,000	10 4	234,000	9 5	1,642,003	20 1	329,000	8 1

(1) For all years prior to 1951, include LPG sold for refueling internal combustion engines.
(2) Not comparable due to segregation of chemical manufacturing.
(3) Not comparable due to change in method of reporting LPG sold for refueling internal combustion engines.
(4) Not comparable due to inclusion of rubber components.
(5) Includes more complete coverage of refinery fuel.
(6) Includes more complete coverage of LPG mixture streams containing ethane and methane.
* Total sales for all years except 1956 were obtained from U. S. Bureau of Mines reports.

during the year.

Rubber components. The use of LPG in the manufacture of synthetic rubber components climbed another 8.1 per cent to an estimated 439,000,000 gal in 1956. This increase is impressive coming on top of last year's 32 per cent increase. Although some synthetic rubber was stockpiled in 1956, next year should continue strong.

Supply. Twenty-six new plants came on stream in 1956 to boost LPG production capacity by almost 1,120,000 gal per day. This additional production capacity, plus increased production at existing plants and the volume in underground storage enabled industry to meet the record breaking demand. It is estimated than 15 new plants will be added in 1957 to further increase production capacity by almost three-quarters of a million gallons per day. In addition, several existing plants are adding facilities and equipment which will also increase the production potential. It is estimated that approximately 75 per cent of the LPG now comes from natural gasoline plants. More than 50 per cent of the liquid produced at natural gasoline plants in 1956 was LPG, with many of the newer plants reaching a ratio of 60 per cent or better. With additional investments and higher operating costs more LPG can be recovered at existing plants but this is economically feasible only with a better and more stable price situation.

There have been continued large increases in LPG storage facilities—both conventional aboveground steel storage tanks and underground storage installations. The estimated available underground storage capacity totals almost a billion gallons and there is about one-third of a billion gallons planned or under construction. The most recent information indicates that this underground storage capacity was substantially full on December 1 of 1956.

Transportation. Transportation facilities kept pace with the increased production and demand. Four new pipe lines were announced or under construction for LPG and refined products. One new LPG tanker was placed in service during the year. There were an estimated 22,000 tank cars in LPG service at the peak of the season. This number would have been higher had the steel strike not postponed delivery of some cars scheduled for the last quarter. The railroads, recognizing the increased costs of owning and operating tank cars and recognizing the inroads which truck transportation has made in the transportation business, are seeking new ways of remaining competitive. Some progress was made in this direction with the approved mileage allowance increase. However, proposed rail rate increases again threatened to further burden industry.

Industry started action to obtain approval of an uninsulated tank car for the transportation of LPG. 1956 saw considerable interest being expressed in water transportation of refrigerated LPG.

The new, higher strength steels appear to offer possible means of increasing payloads of truck transport units. Already 10,000 gal capacity units have been placed in service.

As a part of the LPG industry's never-ending effort to improve its already enviable safety record, numerous changes were again made in NFPA Pamphlet No. 58, the industry "Bible," to keep pace with new developments in equipment and recommended safe practice. Also, a new API standard for LPG storage installations in refineries, natural gasoline plants, and marine and pipe line terminals is nearing completion.

Outlook. The 1956 sales broke all records. The increase alone almost equals total sales for 1944 and the total exceeds all that sold during the first 25 years of the industry. Competition for the consumers' energy requirements continues very keen and the LPG industry must be ever alert if it is to continue such record breaking progress.

The market is far from saturated. "Weather" conditioning (both heating and cooling), motor fuel, and other new applications offer excellent opportunities for the LPG distributor. The Federal highway program offers many opportunities for new and expanded motor fuel applications, trucks, earth movers, graders, road rollers, tractors, etc. Chemical use should continue its amazing growth of the past few years.

LPG distributors are finding it to their advantage and, in fact, necessary to make use of the best accounting practices and most modern business management methods. Evidence of this is shown in the number of and participation in business management and training programs.

The industry should experience another excellent growth year in 1957.

★ ★ ★

Spherical reactors being fabricated for Magnolia Petroleum's Beaumont, Texas, Sovaformer. Made of 2⅝-inch plate, stress relieving was accomplished by covering the vessels with insulation and heating from the inside.

Analytical Methods

Accurate Sampling

with meticulous attention to techniques, careful analysis of the problem and procedure required are imperative to obtain representative samples.

Dave Vondy
Continental Oil Company

SAMPLING of process streams is a daily occurrence in the petroleum and natural gas industries. The laboratory analyses of the gas and liquid streams leaving a gas-oil separator are used to determine the composite well stream analysis from which economics of alternate methods of production are studied. In integrated plants, main process streams are usually sampled periodically, and the analyses of these samples are used to establish the effectiveness of the process, to determine whether or not individual pieces of equipment are functioning properly, to establish changes in operation to obtain improved results, and to design facilities for expansion.

It seems paradoxical that an old set of analyses obtained from samples of questionable source could be used as a basis for establishing the most economical method of processing a certain hydrocarbon stream and the equipment be installed, yet this has happened. A small producer may be more apt to neglect the importance of accurate data than a major company, yet he usually stands to be hurt more by inaccurate data than does the major company because one process or production stream represents a larger per cent of his total operations.

Fig. 1 is a plot of the natural gasoline recovery at a small plant and illustrates how the composition of low-pressure gas from crude oil separators varies. If this gas were sampled during the afternoon (as might be common practice), the analysis would show a much richer gas than actually was available over a 24-hr period. A plant would not pay out the investment as quickly as would be indicated by this mid-afternoon sample. Considering the two extremes in this case, the economic pictures for a plant to handle a 3.7 gpm gas and one to handle a 2.5 gpm gas are quite different, and it is likely that the most economical method of processing is different for the two cases.

Proper sampling technique consists of many small details that are usually learned the hard way, by experience, by each individual involved. The education of one man in suitable technique may cost a company several thousand dollars; yet the actual job of obtaining samples often falls to the lot of a relatively inexperienced hand.

Design of Sample Bombs

Sample bombs should meet the following requirements:

1. Be easy to handle while sampling and easy to transport.
2. Be of suitable design to withstand sampling pressures.
3. Be easy to clean.
4. Be of sufficient size to hold ample fluid for the required laboratory tests.
5. Be completely leakproof.

While a sample bomb should be big enough to hold adequate fluid for the laboratory tests, it need not be bulky. In the average case, 50 cc of liquid are required for a low-pressure fractional analysis of a liquid sample so a bomb having the capacity of 1 pt should be adequate. Table 1 presents the required capacity of gas bomb vs bomb pressure.

TABLE 1. Capacity of Gas Sample Bombs.

Gage pressure psi	Gas capacity Cubic feet Required	Recommended
10	6	12
5	3	6
0	2	4
5	1.5	3
10	1.2	2.4
15	1	2
35	0.6	1.2
60	0.4	0.8
100	0.26	0.5
200	0.14	0.3
300	0.10	0.2
500	0.06	0.2
1000	0.03	0.1
2000	0.02	0.1

Five-gallon glass bottles are used often for sampling low-pressure gas streams unless the gas is at some pressure above atmospheric and expansion is apt to result in condensation. Satisfactory auxiliary equipment includes a two-hole synthetic rubber stopper, two short lengths of glass tubing, ade-

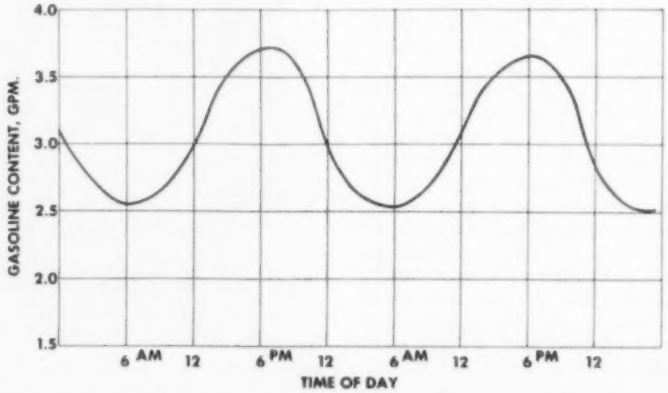
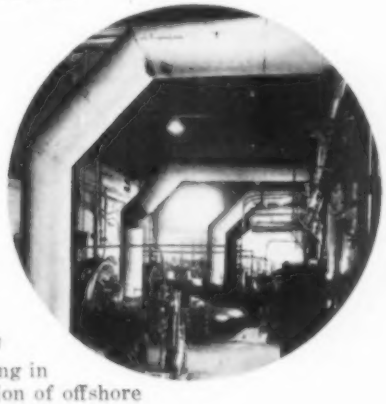


FIG. 1. Curve showing variation in liquid content of gas at different times during the day.

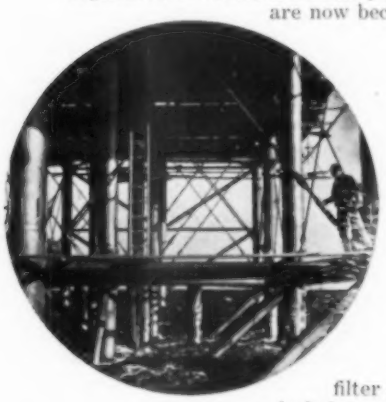
How Monel pays off in equipment exposed to salt solutions

. . . pays off in pumps At Caloil's Perth Amboy refinery, this pump supplies 40,000 GPM of brackish cooling water. To counter the severe corrosive and erosive conditions, its shaft sleeves and 2200-lb. impeller are Monel* nickel-copper alloy. Monel alloy is a money-saver in seawater pumps.



pays off in piping . . .

In this California refinery, light-weight Monel lines proved able to handle salt water years longer than cast iron. This experience has been duplicated so often, Monel alloy piping, fittings, and valves are now becoming standard for such service.



. . . pays off in structurals

The value of Monel alloy sheathing in preventing splash-zone corrosion of offshore structures like this is well-known. A less spectacular but equally valuable use is for plant structurals subject to salt splash, spill or atmospheres . . . tank supports, for example, or just plain nuts and bolts.

pays off in process vessels . . .

These Sharples Super-D-Hydrators filter sodium sulfate crystals, wash them in brine and then dry them. Monel alloy provides just the needed properties for parts . . . . top-notch resistance to both corrosives, strength to handle high centrifugal forces, excellent fabricability.

. . . pays off in heat exchangers, condensers

This barometric condenser is now in service at a large eastern sugar refinery. It features a Monel Clad Steel shell and solid Monel alloy internals. This construction has proved so effective in resisting the corrosive attack of brackish bay water that the refinery has standardized on Monel.

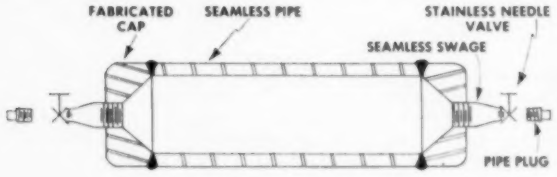
If your equipment for handling seawater and salt solutions is deteriorating faster than it should, an evaluation of Monel alloy in the application may prove helpful. Write Inco's Development and Research Division. *Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N.Y.

INCO Nickel Alloys

Monel ... *for minimum maintenance*

FIG. 2. Details of a suitable design of sampling bomb.



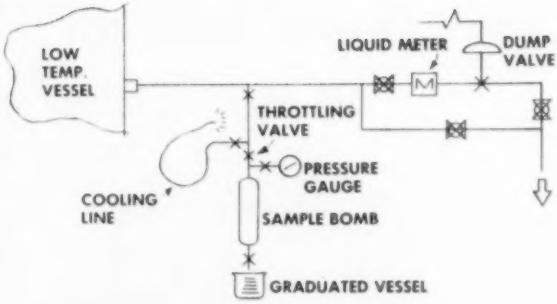


FIG. 3. System for taking low-temperature liquid sample.

quate synthetic rubber hose, and two hose clamps. It is good practice to apply a sealing material to prevent leaks around the stopper. The use of glass bottles is impractical for sampling vacuum streams at a pressure less than about 5 in. Hg vacuum due to the required water leg to balance atmospheric pressure.

Lightweight aluminum or stainless steel bombs are being used extensively because they are easy to handle and also because surplus oxygen bottles were available after World War II. Usually a short ¼-in. nipple and needle valve are used at each end. **Caution:** These bombs may be designed for 300 to 400 psi, but each should be checked before it is used the first time and the working pressure marked on the bomb.

Bombs are often made from steel pipe and welding caps, especially for high-pressure service. A hydrostatic pressure of one and one-half to two times the designed working pressure should be applied and both the working and test pressures stamped on the bomb. Fig. 2 illustrates a suitable design with special caps employed to reduce the possibility of traces of an old sample being trapped when the bomb is cleaned. Usually carbon steel valves are used, but sometimes stainless valves are specified. Copper alloys and high-nickel content alloys are to be avoided because they are attacked by sulfur in the forms in which it is found in natural gas. Bombs for a special service should carry some identifying mark. Bombs should also be numbered for identification.

Special bombs are available or can be constructed. One type of construction includes removable protecting caps that fit over the valves to prevent damage in shipment.

Cleaning Bombs

Thorough cleaning of sample bombs is necessary to remove traces of old material remaining from previous samples. Cleaning is, of course, most important when detailed test work is involved. There are two basic rules:

1. Clean the bombs yourself — they may or may not have been cleaned thoroughly.
2. Steam is the best medium to use for cleaning.

Normally, it is worthwhile to find a local source of steam for cleaning. Often, a light distillate, gasoline or a cleaning solvent is used to clean liquid bombs while natural gas, air, or water under pressure is used to clean gas bombs. After cleaning, the bomb should be filled with water from the bottom to displace all the cleaning agent.

Some laboratories clean bombs by heating them to an elevated temperature and drawing off the vapors under high vacuum. This method is not satisfactory because not all the vapors can be removed and the very heaviest material may not be vaporized. A sample of commercial propane taken in a bomb that had been heated and evacuated showed a content of 0.05 mol per cent i-C_5 and 0.20 mol per cent C_7+. The bomb undoubtedly contained residue material from an old sample.

Selecting Sample Points

Sampling is normally always accompanied by metering of process streams. Good results require proper sampling and accurate metering. Of the many ways that fluid can be measured, probably best and most widely used are: (1) Differential meter with thin, flat, sharp-edge orifice plate in orifice fittings or tapped orifice flanges for gas streams and also for nonvaporized liquid streams between equipment such as on a tower reflux stream, and (2) tank gages for liquids below their bubble point or those to be stored in tanks. Displacement meters are often used satisfactorily for liquid streams containing no vapor, but this type meter should be calibrated at the time of test or the flow rate checked by some additional means.

Normally sufficient streams should be sampled and metered to provide adequate information for a material balance to be calculated. Also, it is often desirable in such cases as a gasoline plant balance to obtain additional information that can be used as check data. In general, each stream metered should be sampled or vice versa. A few examples are detailed below:

Case 1. — A composite well stream analysis is desired for an economic study of various methods of producing a gas-condensate well. Equipment on the lease includes an oil-gas separator, gas meter run, and an oil storage tank. Since special equipment and extreme care are required to obtain a representative sample from a line carrying both liquid and gas, samples will be taken downstream from the initial separation. A sample of and measurement of the separator tail gas and a sample of and measurement of the stock tank liquid will not provide sufficient data. Sometimes a separator liquid sample is withdrawn under pressure, and the reduction in volume is determined when the pressure is reduced to atmospheric. In other tests, a sample of the separator liquid is obtained. Often various combinations of these are used. It is recommended that:

1. The separator tail gas and stock tank liquid be measured.
2. Samples be obtained of both the separator liquid and separator tail gas. These samples alone will establish equilibrium data for the well stream at one condition, and this information can be used to select a suitable reference for equili-

brium constants or to check the analyses for reliability.

3. A stock tank liquid sample be obtained.
4. If there are additional stages of separation, the first-stage separator liquid production rate should also be measured.

A material balance is obtained by calculating a flash of the separator liquid at stock tank conditions, and the stock tank liquid analysis provides a check.

Case 2. — A plant material balance is to be made on a low-temperature separation system with condensate stabilization. Basic equipment consists of a high-pressure separator operated at low temperature from which liquid is fed direct to the top of a non-refluxed stabilizer, and the stabilized bottom product is flowed direct to storage. A check of the stock tank shows that no vapors are being lost. It is recommended that:

1. The separator tail gas, the stabilizer tail gas, and the stock tank production rates be measured.
2. These same streams be sampled.
3. The separator liquid stream be sampled.

Case 3. — A material balance is to be run on a stabilizer column. The feed is below its bubble point ahead of an exchanger adding heat, the overhead product is totally condensed as a commercial propane, a side cut of LPG is taken, and the bottom product is flowed to additional fractionation equipment. It is recommended that:

1. The reflux, propane product, LPG product and either the feed or the bottom product rates be determined.
2. Samples be taken of the propane, LPG, bottom product, and the feed.
3. It may be feasible to measure both the feed and bottom product rates to provide an additional check point in case one of the other rates or an analysis is incorrect.

Case 4. — Gas from four low-pressure crude separators is to be compressed and processed for liquid recovery and sale of the residue gas. Design data are needed. It is recommended that the volume of each gas stream be measured separately, that two samples of each be taken 12 hr apart during normal atmospheric temperature conditions and specifically not in the heat of a summer day, and that the volumetric sums of each test period be averaged for use as the composite stream. (The data obtained are suitable for design of a plant to handle the gas available at the time of the test but cannot be used to predict reservoir conditions, reserves, or change in gas analysis or quantity with time without additional reservoir data.)

Gas Samples

Gas streams should, in general, be sampled from the flowing stream at line pressure and at a temperature above the dew point (above the immediately preceding separation temperature) from the top of the horizontal line or from a vertical line by water displacement. Gas may be expanded into a bomb only if it is sufficiently below the retrograde region to avoid condensation upon expansion. Liquid carrying down the wall of a pipe, as is likely if a vessel is "carrying over" or if this gas has been cooled after leaving the immediately preceding separation, will generally cause erratic results. If the gas is normally heated in the process or the atmospheric temperature is above that of the separation, the sample should be taken at the hottest point; if the stream is not heated and the outside temperature is below that of the separation, the sample should be taken close to the separation vessel but preferably not directly from it. When sampling by water displacement, the water in the bomb should be hotter than the gas. Purging of a bomb is practiced widely instead of water displacement, but is not recommended due to the possibility of condensation with expansion and resulting reduction in temperature. Water displacement may cause solution loss of a small amount of some components, especially CO_2 and H_2S; if the content of these components is desired accurately, sampling without water contact may be more suitable.

Liquid Samples

Liquid streams should in general be sampled from the flowing stream at a temperature below the bubble point (below the immediately preceding separation temperature) from the side of a horizontal line by water displacement upstream from any control valves in operation. Liquid should never be expanded into a bomb except as described under "Cold Liquid." A liquid stream after being heated or expanded through a control valve cannot be readily sampled due to the resulting two-phase flow. Water in the bomb should be colder than the liquid sampled unless the liquid stream is in a subcooled state.

In the case of two-phase liquid flow, care must be taken to obtain a sample of the desired phase. Usually, it is necessary to sample directly from a separation vessel, preferably close to the point of liquid dump. As an example, a sample of the condensate removed from a gas stream is to be taken from a separator through which also flows a large amount of water. The sample can be taken from the vessel above the liquid draw-off point but below the gas-oil interface.

Liquid samples should be drawn from the flow lines rather than from separation vessels except in the case of two-phase liquid as the line liquid is more apt to be representative of the process. The liquid-level gage is a particularly bad place from which to remove a sample. In the extreme case, consider a low-temperature separator in which the liquid is heated. In a typical example, the liquid-level gage connects gas that is at 25 F with liquid at 70 F. If the sun is shining directly on the unit, this gage may well be above 70 F. The state of the liquid in the gage will remain unknown regardless of how well the gage is purged, vented, etc. Even on a crude oil separator the liquid-level gage will be at some temperature other than that at which the separation occurs. For want of a better sample point (or lack of any other), the gage can, of course, be used if the top cock is closed and the gage thoroughly purged, but this practice should be avoided.

Often it is desirable to cool a volatile liquid before it is flowed into a sample bomb. Satisfactory use has been made of a coil submerged in a bath of cold water or other coolant.

Cold Liquid

Fig. 3 illustrates a satisfactory method for sampling a stream that is well below the freezing point of water. The bomb is filled with a 50-50 mixture of glycol and water. The sampling lines are kept cold by the cold spray. The glycol-water mixture is withdrawn slowly while the pressure is maintained by bleeding in sample through the valve next to the bomb, but back flow of vapor is prevented by keeping the bomb at a pressure somewhat below that of the line. When one-half of the glycol-water solution has been withdrawn, the drain valve is closed, the bomb is brought nearly up to separator pressure, and the inlet valve is

closed immediately. The other top valve is closed and the valve on the line is closed. The valve to the pressure gage is closed and the gage removed. The bomb is removed and one-fourth the original glycol-water capacity is drained from the bomb to allow for the expansion that will occur when the bomb becomes heated. The bomb is tested for leaks, the packing glands are tightened on the valves, and pipe plugs are installed. Samples were taken from five separators, each having a liquid temperature at about 10 F, and only the one sample obtained in this manner could be considered satisfactory.

Caution: Liquid "outage" is a must and the condition of the sample should be explained to the laboratory so that an adequate procedure can be used for the analysis.

Sampling Tanks

It is quite difficult to obtain a sample of the liquid in a stock tank without losing some of the sample as vapor. This vapor loss will occur if an open bucket is used to dip a sample and the liquid then poured into a container. Also, an open container or one that will not hold pressure will lose vapors due to exposure to air and even worse due to elevated temperatures. A sample obtained from the center of a tank by use of a siphon will likely lose vapor due to reduction in pressure.

One of the main difficulties encountered in sampling stock tanks is difference in composition existing through the tank. The vapor pressure of the material toward the bottom of the full tank will be higher than that at the top if the material is at a common temperature because the liquid head causes the absolute pressure to be higher in the bottom. If cold liquid is fed to the top of a tank, the vapor pressure of that material at the top and that at the bottom will likely be higher than that at the center of the tank due to the higher pressure at the bottom and the lower temperature at the top. If the atmospheric temperature is above that of the tank, the edge material in the tank is hotter than that in the center and and the compositions of the liquids at the two locations are different. Also, during test work, the compositions of the liquids at the two locations are different. Also, during test work, the composition of the material in a receiving tank may differ from that of the material being flowed to the tank. If material that is above its bubble point at tank conditions is flowed to a tank containing material below its bubble point, measured production will be higher than if the material were flowed to an empty tank, and a sample of the tank liquid will not represent that material flowed to the tank. If material at its bubble point is flowed to a tank that contains liquid at its bubble point but the new material is at some higher temperature, the tank will become heated and some loss of the material originally in the tank will occur and the liquid compositions will not be the same.

In general, a test should begin with an empty tank or with material in the tank produced only under the same conditions as to be used in the test. A suitable sample can be obtained from the liquid in the tank to prevent vaporization in this discharge line. Also, a sampling connection extended on the inside toward the center of the tank can be used satisfactorily and is often used for pressure tanks. If no vapor is lost from the tank, the best sampling point is in the flow line to the tank upstream from control valves. When any of these methods of sampling are used, the sample should be taken by water displacement.

The Author

Dave Vondy has recently been employed by Continental Oil Company in offshore production. He was graduated with a BS in mechanical engineering from the University of Colorado in 1950 and served as a design engineer with Black, Sivalls & Bryson, as a process engineer with Tuloma Builders, and as a development engineer with Delta Tank Manufacturing Company.

Method of Withdrawing Sample

Before a set of samples is taken for a test, the relative change in rates of flow should be established. A test period of less than 24 hr is in most cases unsatisfactory. During normal conditions, the atmospheric temperature cycles over a 24-hr period. Storage, separation, and cooling water and cooling air temperatures usually exhibit this 24-hr cycle. Fig. 1 presented earlier illustrates that test periods in even multiples of 24 hr will give satisfactory results, but those of uneven fractions of one or more days will not. A period of 48 hr is recommended for most test work. There are exceptions to this where the operating conditions and feed material are controlled or remain constant. A plot of flow rate vs time should be made for, say, 2 or 4-hr periods to establish variations from the mean or any normal cycling period. For example, this procedure is necessary to establish that a producing well is stabilized at the test rate unless it has been continuously produced at this rate. Operation data should be recorded at regular intervals and any variation analyzed. Also, it would be illogical to withdraw samples during an abrupt change in atmospheric conditions as would be the case if a rain storm came up at the end of a test period. Furthermore, a test should be made at the proposed flow rate for future operations because the operation of equipment differs with flow rate and the composition of a well stream varies with production rate.

Generally, samples are used for the purpose of (1) establishing average composition or (2) establishing composition for a short period. Samples taken over a very short period are suitable for establishing composition for this short period as would be desirable in establishing the effectiveness of a piece of equipment such as a fractionator, but could be used for an economic study of methods of processing the sampled stream only if the composition of the stream remained relatively constant or the sample were taken under average conditions. Thus, a sample of the tail gas from a crude oil heater-treater taken when the treater was at a higher temperature than the yearly average or at a lower pressure than it would be under future operating conditions would result in a distorted analysis of the gas, which would indicate a higher gallons per minute content than would be realized if this gas stream were processed.

To avoid the problem of selecting average conditions under which to test, a popular practice is that of using special sampling equipment designed to withdraw automatically a small sample continuously or periodically and having the composite of these samples analyzed. Also, a fraction of a sample bomb can be filled periodically by hand, say, every 4 hr over the test period. Note that periodic sampling should not start and end over a 24-hr period, but rather the sampling period; that is, if the first sample is taken at 12:00 noon and additional ones are taken every 4 hr, the last should be taken at 8:00 a.m.; or if these samples are taken every 12 hr, the last should be taken at 12:00 midnight rather than at noon. Periodic or continuous sampling devices should be connected as close to the sample point as possible to reduce the static volume of the connecting line to a minimum.

When many samples are taken from a continuous process, the main stream(s) should be followed through the plant; that is, the first sample obtained should be at the beginning of the process and the last that at the end of the process.

Water Displacement Sampling

Presented below are satisfactory procedures for obtaining samples by water displacement. It is assumed that the

sample bomb has a valve on each end.

In all cases:

1. Check bomb for service intended, satisfactory valves, etc.
2. Clean bomb.
3. Fill bomb completely from the bottom with water.
4. Attach bomb to the sampling point (copper tubing if stream contains no sulfur compounds, steel pipe, synthetic rubber hose of sufficient working pressure, etc.).
5. Purge the line between the sampling point and the bomb and tighten fittings.
6. Open the top valve on the bomb (inlet valve for the sample).

For gas:

7. Slowly withdraw water from the lower valve until gas bleeds.
8. Close drain valve, inlet valve, and valve at sampling point and remove bomb from the line.

For liquids:

7. The bomb should be so located that the inlet valve is below the sample source (except for sampling under vacuum) and the bomb supported in such a position that only one-half to three-quarters of the water it contains will drain out and the remainder be retained. Slowly drain the water until the liquid being sampled begins to flow. The bomb remains one-quarter to one-half full of water.
8. Close the drain valve, inlet valve, and valve at sampling point and remove the bomb from the line. Holding bomb vertically, drain out a quantity of water equal to approximately 10 per cent of the capacity of the bomb and then close the drain valve. Do not drain any of the liquid sample from the bomb as this will change its composition. In the prescribed manner, approximately 10 per cent "outage" is taken to prevent the bomb from becoming overpressured should it become heated. **Caution:** "Outage" must be taken to avoid the dangerous condition of excessive pressure, which will normally occur with temperature rise.

In all cases:

9. Check the bomb for leaks by submerging it in a water bath.
10. Tighten the packing glands on the valves and install steel pipe plugs to seal the valves. The use of soap as a thread seal is recommended, but not the use of a hydrocarbon liquid or paste.
11. Should for any reason it be suspected that the sample is unsuitable (it may be that the bomb leaked, liquid sample drained from the bomb when "outage" was taken, or the sample was taken under poor conditions), the sample should be dumped and another taken or an additional sample should be taken.

In some standard procedures, it is the practice to take two samples of each stream, and either both samples are analyzed or one is held in reserve to be analyzed if the first is found to be incorrect. This practice may save the expense of returning to the location. Although often the second sample is as unsuitable in material balance as is the first, should one sample bomb leak, the second is likely to be not only satisfactory but very much needed.

Tagging Sample Bombs

A sample bomb containing a sample should be thoroughly identified by a tag, and also suitable data should be recorded in the test notes so that a bomb containing any sample can be identified and information about the sample will be available should the tag on the bomb become lost. If many samples are taken, it is good practice to number both the test and the sample. The sample tag should contain sufficient information so that the laboratory technician will know approximately what the sample is and under what conditions it is contained in the bomb so that proper techniques can be used for removal and analyzing.

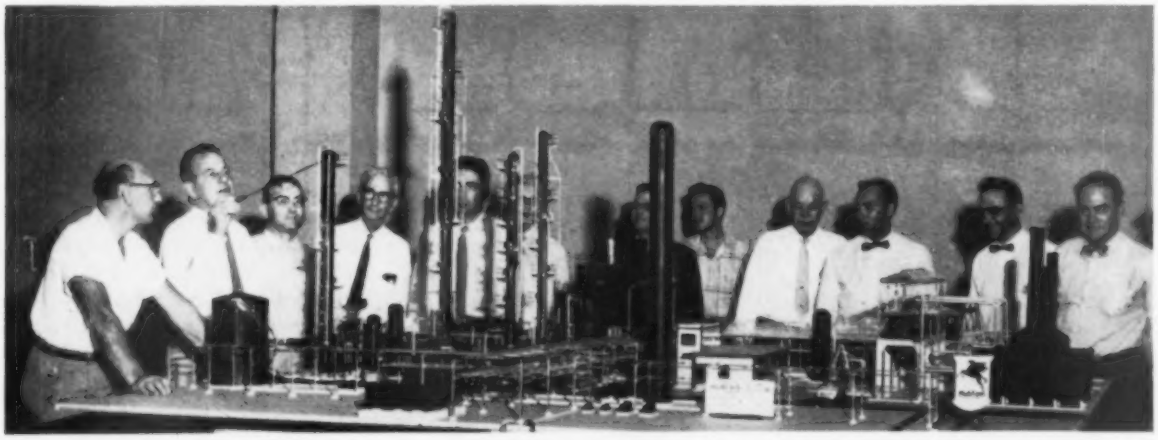
The tests to be run on the sample should be given on the tag. A careful study should be made to determine the tests to be made. Often no, or only one, property of the heaviest fraction in a gas sample is determined while two are necessary to establish its other properties, and these properties must be known if accurate process calculations are to be made using the analysis as a basis. The nitrogen and carbon dioxide content of gas must be known before its heating values can be determined. In addition, it is often desirable to have some property determined which can be used to check that obtained in the field; in this manner, a poor sample can be readily recognized and eliminated.

(Sample Tag)

To:
Laboratory: Johnson Laboratory, 600 No. Street, Tampa, Florida.

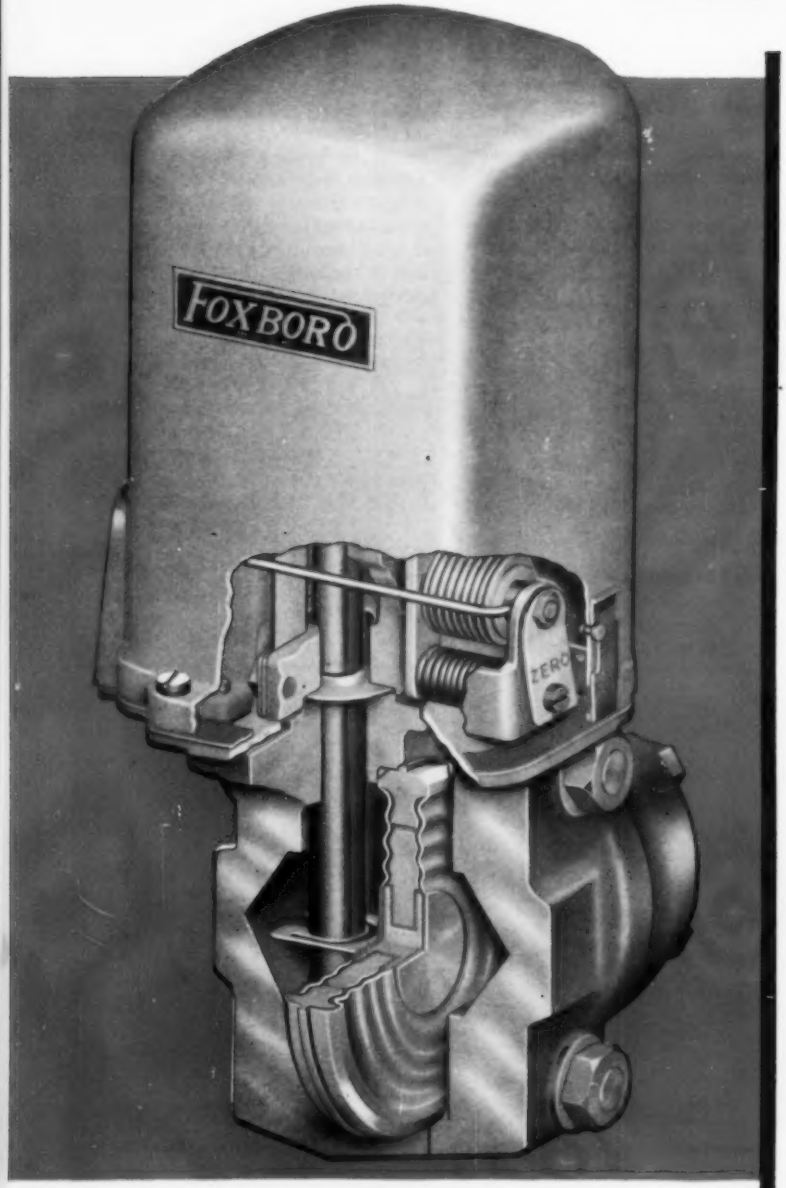
From:
Company: Sam Petroleum Company.
Test Location: Local Gasoline Plant.
Sampled by: John Sam.
Method of Sampling: Water displacement, 10 per cent outage.
Time: 6 p.m.
Date: 1-26-56.
Test No.: Plant Balance No. 2.
Bomb No.: 12-A: Deethanizer bottom product.
Sample Type: (Liquid 80 psi RVP±)
Pressure: 350 psi.
Temperature: 300 F.
Laboratory Tests Required:
mol wt C_7+
sp gr C_7+
mol per cent to C_7+
Reid Vapor Pressure (if sufficient sample)

★ ★ ★



Plant models in action. Socony Mobil engineers meet with designers at J. F. Pritchard and Company's Kansas City, Missouri, offices to discuss final piping and plant layout for the 9000 bbl per day Sovaformer to be built at Socony's Augusta, Kansas refinery. All agreed that models are far superior to drawings for such purposes, speeding work and reducing potential errors.

ONLY the Type 13A d/p has these 6 advanced-



- **Positive Overrange Protection** up to full 1500 lb. rating
- **Fully Adjustable Ranges . . .** 0-20" to 0-80" and 0-50" to 0-250" H_2O differential
- **Automatic Internal Damping** . . . fast, *stable* measurement
- **Simplicity** . . . easiest, lowest cost installation, least maintenance
- **Convenient Zero Adjustment** . . . external — no need to remove weatherproof cover
- **Highest Sustained Accuracy** . . . even under extreme operating and ambient conditions

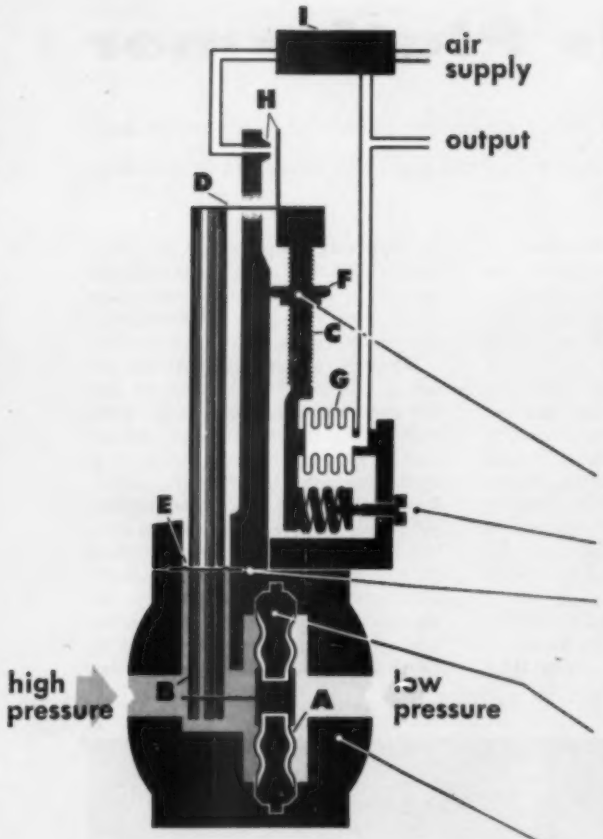
With these basic features, plus many other technical refinements throughout, the new Type 13A d/p Cell* Transmitter surpasses all previous records in performance . . . economy . . . convenience. For the complete story and a demonstration, call your nearest Foxboro representative. Write for new Bulletin 13-11. **The Foxboro Company, 642 Neponset Ave., Foxboro, Mass., U.S.A.** Factories in the United States, Canada and England.

*Reg. U. S. Pat. Off.

More Foxboro flow transmitters are in use by the process industries than all other makes combined!

Cell Flow Transmitter

design features...



How It Works . . .

An increase in differential pressure across Twin-Diaphragm Capsule (A) exerts force to right on force bar (B). Elgiloy® diaphragm seal (E) acts as fulcrum. Force to left at top of bar (B) causes flapper to approach nozzle at (H). Resulting increase in nozzle pressure is amplified by relay (I). This pressure is sent to feedback bellows (G) which develops force to counterbalance the differential pressure on capsule (A). The 3-15 psi output signal from relay (I), always precisely proportional to differential pressure, is transmitted to remote recording or controlling instrument.

Range Wheel is continuously and easily adjustable for entire range whether 0-20" to 0-80" or 0-50" to 0-250" H_2O.

Easy-access screw adjustment permits field "zeroing" without removing weatherproof cover.

Elgiloy® stainless alloy diaphragm seal assures a corrosion-resistant, frictionless, positive pivot point. Instrument is constructed in 3 basic units — body, transmitter, and air relay block — eliminating all possibility of errors produced by piping stresses.

Silicone-filled Twin-Diaphragm Capsule filters out flow disturbances ("noise") at measurement source . . . without loss of speed of response. Precisely matched surfaces of diaphragms and capsule core provide "stops" which give positive overrange protection in both directions.

Rugged forged body, optionally Type 316 S.S. or carbon steel, gives greatest strength with least weight . . . ultra-compact design permits low cost mounting from flange taps.

FOXBORO
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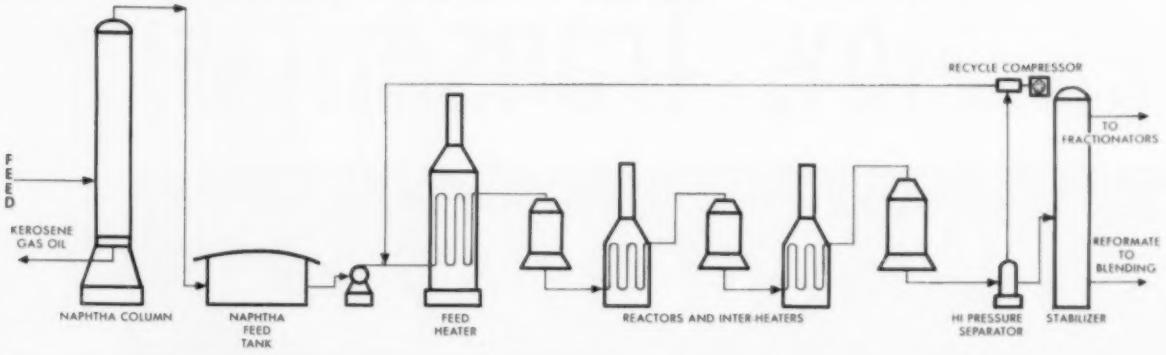
First in Flow Instrumentation

Octane problems are solved when...



Winnie Processing Plant Installs Platformer

Adaptation of an earlier catalytic conversion unit enables Texas Gas Corporation to produce 100-plus octane gasoline

Whit Downer
Associate Editor

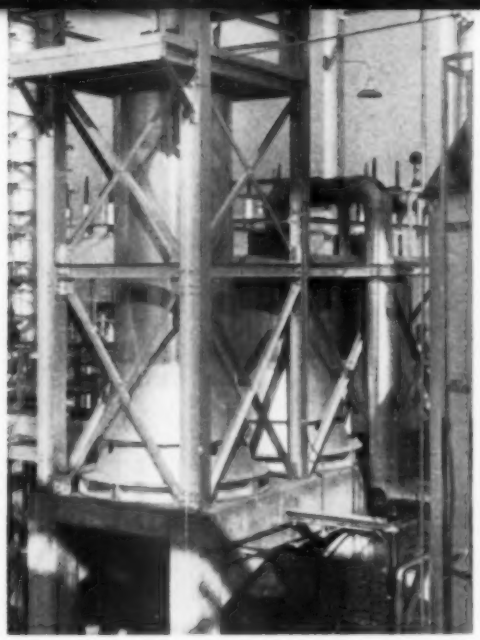
FACED with tough competition in the burgeoning motor gasoline octane race, Texas Gas Corporation began reforming of naphtha in early July, 1955. The installation at the Winnie, Texas, processing plant was one of the first of several platinum catalyst reforming units now operating in the gasoline industry. Formerly limited to a top octane of 86 CFRR with 3cc TEL, the Winnie plant can now provide motor gasolines rating at 100 CFRR or better. Good yields, coupled with reasonable operating costs have demonstrated fully to Texas Gas the feasibility of the installation.

The Platformer replaced a naphtha conversion unit of an earlier design . . . by utilizing most of the equipment from the older unit, out-of-pocket costs were held to $325,000, including the catalyst charge. In fact, the only new major facilities were the three UOP-designed, Procon-constructed reforming reactors.

Designed to process 2500 bbl per day of 200 to 400F naphtha, the unit has demonstrated ability to go much higher than this level. Also, the run showed good catalyst life. The first run on the unit lasted for 385 days, equivalent to about 120 bbl of feed naphtha per pound of catalyst. While the catalyst had deactivated somewhat towards the end of this run, primary reason for termination was to replace the old catalyst with a more dense, more active catalyst that had been developed by UOP. Higher bulk density of the new

Mixon "Mickey" Kincannon, manager of the Winnie plant, tells THE REFINING ENGINEER why the Platformer was installed.

Aerial view of Texas Gas Corporation's Winnie plant. The Platformer is in the center foreground.



Catalyst cases are located among the furnaces, exchangers, pumps, and control house that were part of an earlier cracking unit.

Large furnace to the left is the feed preheater. Two smaller furnaces in the center are inter-reactor heaters. Reactors can be seen in the background at the far right.

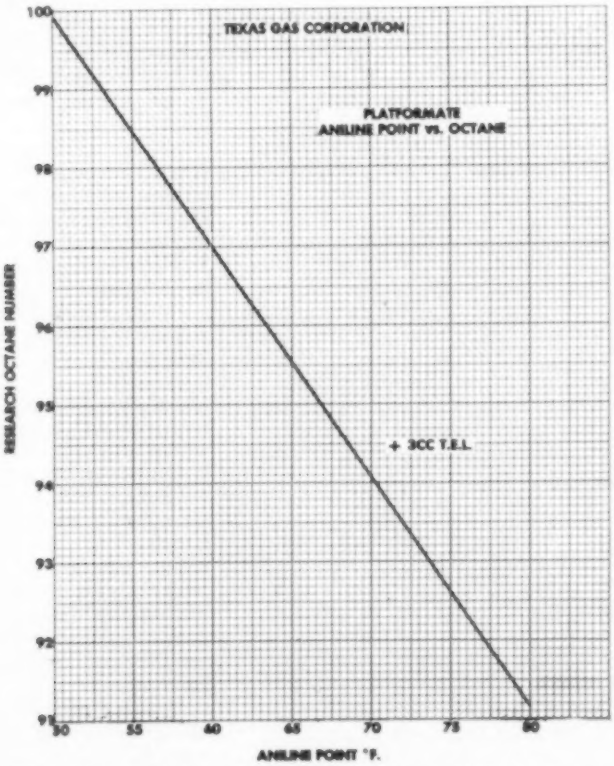


FIG. 1. Primary control on unit is Platformate octane number. Operators run aniline point on stabilized product two-three times a shift, use this correlation to determine Research octane at 3cc TEL.

catalyst permitted a greater weight of catalyst in the reactors, hence higher octanes at a given reactor temperature level.

The feed to the unit contains essentially no catalyst poisons and sulfur content is low enough to eliminate potential corrosion problems. Maximum allowable final boiling point on the feed is 400F; if higher than this, carbon build-up on the reforming catalyst would accelerate rapidly. Initial boiling point of the feed is held at 200F, minimum to assure nearly complete exclusion of light ends. Some of the more important feedstock characteristics are as follows:

ASTM Distillation		Chemical Analysis	
IBP	200 F	Paraffins	54 LV %
10%	227	Naphthenes	36 LV
50%	270	Aromatics	10LV
90%	344	Olefins	trace
FBP	395-400	Sulfur	0.009 wt %

Reforming severity is varied according to demand for each of the five grades of motor gasolines that are blended at the Winnie plant. When making a 97 Research octane product containing 3cc of TEL, the stabilized Platformate yield is in the region of 90 liquid volume per cent. While demands have not yet required that 100 octane product be made, tests have shown liquid yields of about 80 to 83 per cent when operating to make 100 octane with 3cc of lead.

The Platformate stabilizer is operated in such fashion as to assure complete removal of propane and isobutane; while the stocks have higher octanes than normal butane, the higher vapor pressure of the isobutane restricts the amount that can be blended into finished gasoline. Replacement of the isobutane with normal butane that is produced in the natural gas processing section of the plant thus permits higher octane of motor gasoline along with higher overall yield. Also not to be overlooked is the premium price that isobutane commands over normal butane.

Overhead product from the stabilizer is sent to fractionation equipment for light ends recovery. All of the Platformer's products, excepting hydrogen,

are thus turned into salable products: Methane and ethane go out in the company's gas products line and propane, traces of normal butane, and isobutane are recovered as separate products. The hydrogen is used in the plant fuel system.

Once considered to be a natural gasoline plant, the Winnie processing plant is for all practical purposes a combination liquids-recovery plant and refinery. The plant processes 200,000 Mcf per day of gas and 4300 bbl of distillate and crude condensate daily . . . 2100 bbl of this is brought in by tank truck . . . while the balance is recovered from the gas stream. Products include five grades of gasoline, two grades of diesel fuel, range oil, fuel oil, propane, normal and isobutane, and isopentane.

Each of the five grades of gasoline, that range from 60 to 97 CFRR octane number, are a trinary blend of normal

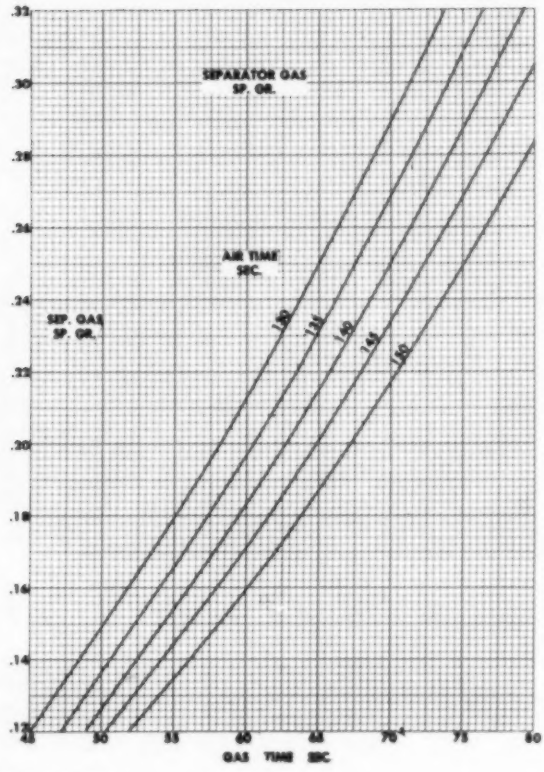
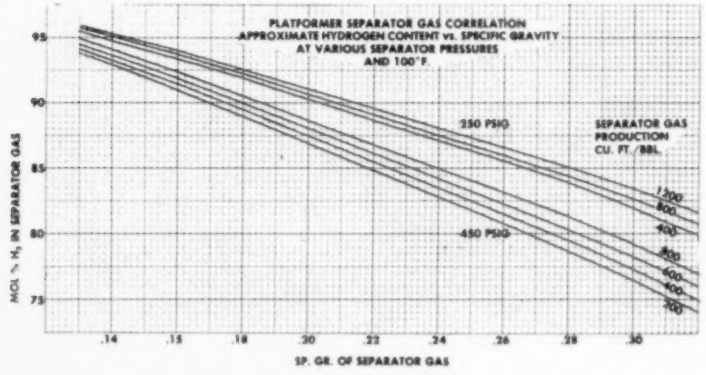
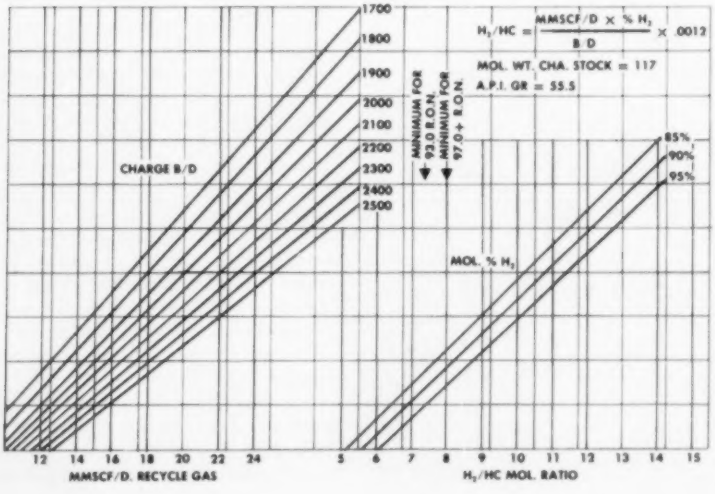


FIG. 2. The Platformer's operating guide has many correlations that the unit's operating people use. Using charts shown on this page, operators check the approximate hydrogen/hydrocarbon ratio, an important variable in catalytic reforming. Meters give charge and recycle gas rates while the operators run test for specific gravity of the recycle gas stream — the latter correlates with hydrogen content. These charts are quite valuable in time of emegency such as loss of one of the two recycle gas compressors, cut in feed rate, etc.


PLATFORMER SEPARATOR GAS CORRELATION
APPROXIMATE HYDROGEN CONTENT vs. SPECIFIC GRAVITY
AT VARIOUS SEPARATOR PRESSURES
AND 100°F.
250 PSIG
450 PSIG
SEPARATOR GAS PRODUCTION CU. FT./BBL.
MOL. % H2 IN SEPARATOR GAS
SP. GR. OF SEPARATOR GAS

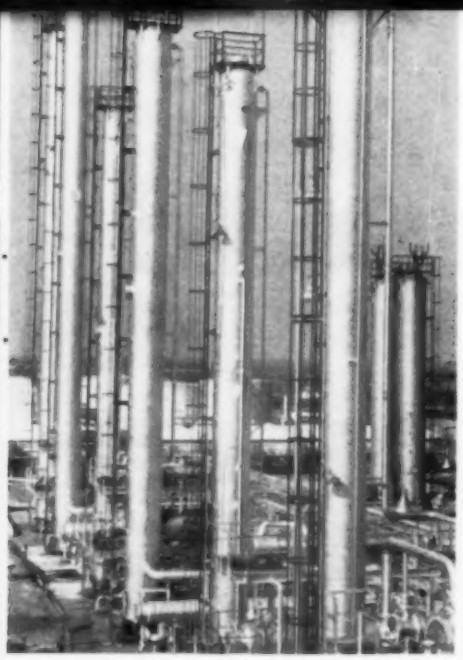

H2/HC = MMSCF/D × % H2 / B/D × .0012
MOL. WT. CHA. STOCK = 117
A.P.I. GR = 55.5
MINIMUM FOR 93.0 R.O.N.
MINIMUM FOR 97.0+ R.O.N.
CHARGE B/D
MOL. % H2
MMSCF/D. RECYCLE GAS
H2/HC MOL. RATIO

butane, isopentane, and Platformate. Octane number is controlled primarily by the severity of operations on the Platformer while fine adjustments are made by adjusting TEL content.

Varying availability of feedstock is absorbed both by feed tankage and the wide flexibility in permissible charge rate to the unit. Naphtha storage capacity gives sufficient time for a catalyst change shutdown without effecting operation of other units in the plant.

Justification of the Platformer was not difficult. Mixon Kincannon, manager of the Winnie plant, told *The Refining Engineer* that while the Platformer was a "must" for remaining competitive in the octane race, that it was justified over the older cracking process on a clear dollars and cents operating cost, maintenance, and yield basis.

Making the most of equipment associated with an earlier-type catalytic conversion unit, Texas Gas kept out-of-pocket cost for the Platformer at a minimum. Adapted to the Platformer from the older unit were the charge furnace, product stabilizer and its reboiler furnace, and most of the heat exchange train. Also, a steam superheater and a rerun tower reboiler furnace were retubed to permit their use as inter-reactor heaters. Two 40-hp compressors that were associated with



Towers that are part of the natural gas liquids processing section also process Platformer stabilizer overhead products. The stabilizer is in the right foreground.

TEXAS GAS CORPORATION
WINNIE PLANT
Daily Yield and Operating Report

24 Hours ended 7 A.M. _____ Date _____ 195___

TOPPING OPERATIONS	TODAY		MONTH TO DATE		PLATFORMING UNIT	TODAY		MONTH TO DATE	
	Barrels	$	Barrels	$		Barrels	$	Barrels	$
Charge: Distillate		100.00		100.00	Charge: Naphtha		100.00		100.00
Production:					Production:				
Propane					Propane				
Iso Butane					Iso Butane				
Normal Butane					Normal Butane				
Iso Pentane					Platformate				
200 E. P. Gasoline									
Naphtha Charge Stock					Loss (Gain)				
Heavy Naphtha					TOTAL		100.00		100.00
Range Oil Gas Oil Stock					GASOLINE ABSORPTION PLANTS	MCF	$	MCF	$
80-400 Rec'd from system									
Range Oil					Charge: Low Pressure Gas				
No. 2 Diesel					High Pressure Gas				
Gas Oil					TOTAL		100.00		100.00
						Barrels	GPM	Barrels	GPM
					Production:				
					Mix to Carbide & Carbon				
					Propane				
					Iso Butane				
					Normal Butane				
					Iso Pentane				
					200 E. P. Gasoline				
					Naphtha				
Loss (Gain)									
Total		100.00		100.00	TOTAL				

FIG. 3. A daily operating report is management's guide. This form provides a good idea of the variety and complexity of operations in the Winnie Processing Plant.

the old unit were adapted for use as recycle hydrogen compressors. In more conventional reformer designs, the reactor effluent provides reboil heat to the reformate stabilizer; having a stabilizer reboiler furnace available, reactor effluent preheats feed in this installation. This flow pattern permitted utilization of lines and heat exchangers that were part of the old cracking unit.

Attention to engineering details, through training of operators, and the help of a UOP start-up crew have all led to a minimum of operating difficulties. The only regular maintenance on the unit is a weekly check and calibration of instruments. An instrument technician can do this in about eight hours. Two men operate the unit, with one stationed in the unit's control house and the other in the compressor building.

Having had more than a year's operating experience, Texas Gas relies on the shift operators to handle all but the most complex problems and details in the day-to-day operations. The operators use about 15 charts to determine and control reforming severity, hydrogen recycle rate, proper stabilizer operating conditions, etc. The chief operator runs all of the analyses that are necessary for evaluation of operations; tests such as aniline points on the stabilized reformate, specific gravity of recycle gas, boil-away points on stabilizer reflux and overhead are run two or three times per shift.

Aniline point of the stabilized Platformate has been found to correlate with its leaded octane rating and the chart shown on Fig. 1 is used for this purpose. Another chart aids the operators in adjusting chlorides addition rate when the feed rate or desired catalyst activity varies. The series of charts shown in Fig. 2 are used to check the vital hydrogen/hydrocarbon ratio. If the ratio is too high, capacity in the Platformer is being wasted, while if it is too low, carbon deposits will build up more rapidly on the catalyst. Several charts are used to correct gas and liquid flow rates to standard conditions of temperature and pressure.

Shift reports prepared by the chief operators provide the process engineers with all of the information required to make up the detailed daily yield and efficiency analysis. Liquid yield is converted to a constant basis, 93 octane at 3.5 RVP, for comparison with operations for other days in the run period. For example, the per cent recovery at constant (adjusted) octane number is plotted against cumulative barrels of feed per pound of catalyst. While the overall pattern is "shot gun," definite trends in catalyst activity can be spotted and if undesirable corrected.

Proper time for replacement of the catalyst with a fresh charge is rather difficult to determine because of wide fluctuations. With the use of trend plots, however, process engineers are able to figure average liquid and gas product yields and assign a realization value to them. By comparing this with realizations predicted for fresh catalyst, the "breakeven" point or point of justification for purchase of fresh catalyst can be determined.

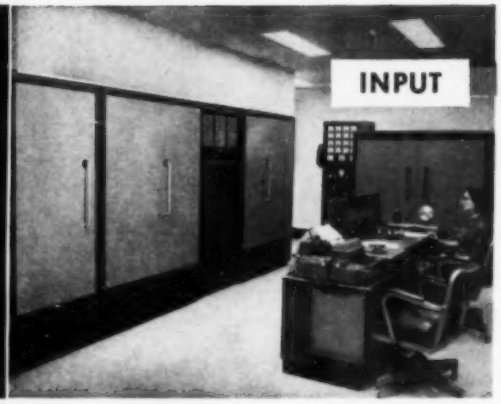
While an operating manual had been prepared prior to start-up of the Platformer, still another operating guide was prepared after about a year's operations. Written by C. C. Albritton, operations superintendent for the Winnie processing plant, it contained, among other things, answers to over 100 questions that had been submitted by operators. Many were questions that would normally go unanswered for months and even years. Covering items such as proper actions to be taken in the event of a charge pump failure to complex theory on chemical reactions and catalysis, the operating guide has succeeded in making its operators aware of operating variables and why their control is important. The Platformer operators have been given the training and tools necessary to keep a smooth, efficient operation. By so doing, process engineers can devote their time to long range problems. And, the operators have great responsibility, return this faith in them with conscientious effort, close attention to details. Texas Gas believes that this program has paid well in both employee relations and in profits. ★ ★ ★

Platformate Distillations Obtained at Various Octane Levels.

	Feed	Product			
Octane:					
CFRR clear	48.2	—	—	—	—
3 cc TEL	72.0	97.0	96.6	93.4	93.2
API gravity	55.2	52.1	52.8	51.2	52.2
IBP, °F	206	114	124	130	130
50%	266	248	250	252	256
FBP	394	414	409	406	406

Electronic Route to

Super-Speed Computer Minimizes Heat Transfer Surface Requirements of Heat Exchangers . . .



Control section of Kellogg's computer

IN DESIGNING heat-pressure process equipment, the addition of a large magnetic drum digital computer to M. W. Kellogg's facilities enables the company's engineers to study variables and produce results with unprecedented thoroughness, accuracy, and speed. Human error is practically eliminated.

To Kellogg's customers in the petroleum and chemical industries, this new electronic aid means that Kellogg engineers can devote more time to basic design problems, and provide equipment with maximum operating efficiency, minimum maintenance costs, and the lowest possible initial investment.

In the case of heat exchangers, for example, design calculations require a trial and error solution. The time required to do this with hand calculations seldom permitted several design alternates. Thus the engineer never could be sure that the design selected was the true optimum. With high speed electronic computation, however, the greater number of alternates economically possible now brings the ultimate or near ultimate design to every Kellogg customer.

In one instance recently, involving 37 heat exchanger shells, the greater number of calculations achieved with the electronic computer resulted in reducing total heat transfer surface requirements by more than 15% from estimated values. Without the computer, the time required to obtain this value would have outweighed the saving many times, and would have been prohibitive.

Kellogg welcomes the opportunity to put its electronic computer and other engineering facilities to work for you. Arrangements to see the computer in operation in Kellogg's New York office can be made by contacting the company's Fabricated Products Division.

Fabricated Products Division • THE M. W. KELLOGG COMPANY • 711 Third Avenue, New York 17, N. Y.

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The Canadian Kellogg Company Limited, Toronto • Kellogg International Corporation, London • Societe Kellogg, Paris
Kellogg Pan American Corporation, New York • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

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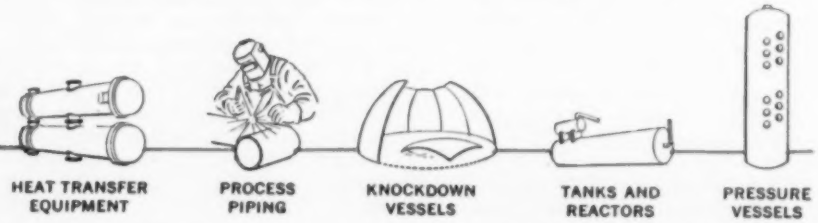

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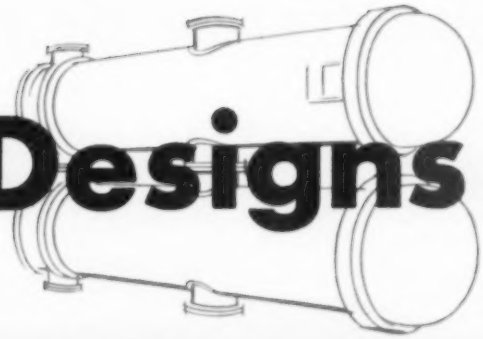
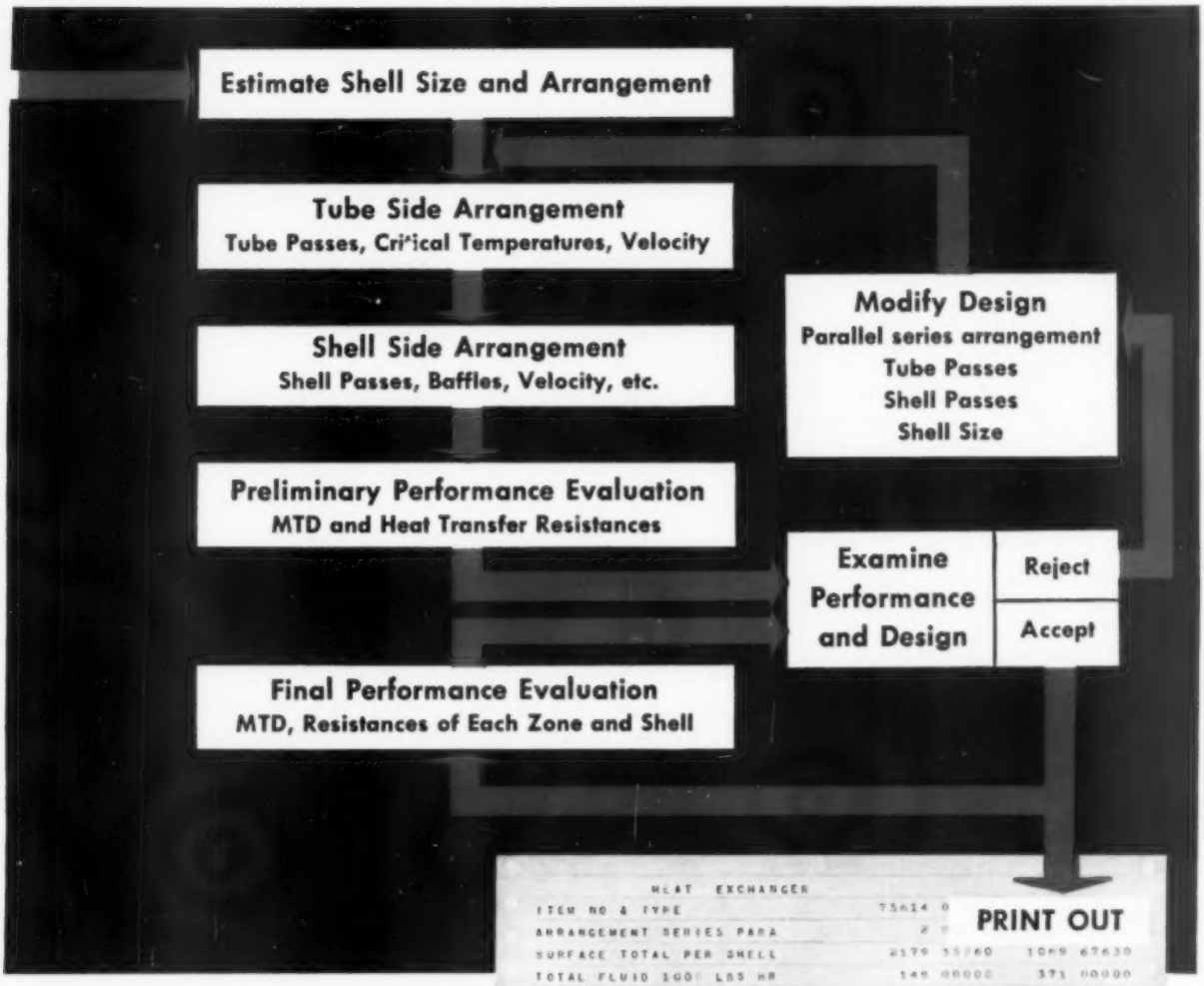
Optimum Designs





This liquid-liquid heat exchanger design flow sheet shows the route taken by Kellogg's electronic computer to obtain optimum design results. The boxes shown at right indicate the paths taken by the machine in arriving at the solution. Photograph at right is of a partial tabulation, showing how the computer presents results.

HEAT EXCHANGER

ITEM NO & TYPE	75614 0			
ARRANGEMENT SERIES PARA	2 0			
SURFACE TOTAL PER SHELL	2179	35760	1069	67630
TOTAL FLUID 1000 LBS HR	148	00000	371	00000
SP GRAVITY LIQUID		87670		67620
TEMP VISCOSITY F CS A	53130	01306	53130	01706
TEMP VISCOSITY F CS B	53300	01102	53300	01205
TEMPERATURE HOT	300	00000	350	00000
TEMPERATURE COLD	130	00000	286	00000
TUBE PASSES PER SHELL		00000	2	00000
PRESS DROP ALLOW PSI	10	00000	15	00000
PRESS DROP CALCD PSI	9	96980	11	26021
FOUL RESIST & TUBE DIAMTR		00004	1	00000
DUTY MM BTU HR & MTD XTD	13	30000	87	64713
TOTAL RESIST SERVICE CALCD		01436		01163
DESIGN PRESSURE PSI	150	00000	300	00000
TUBE NUMBER AND LENGTH FT	212	42078	20	00000
SHELL IDS DIAM BAFF PITCH		300	8	81250

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Computers Shorten Refinery Planning Time

Robert G. Donovan
and Robert W. Schrage
Esso Standard Oil Company

DURING the last few years digital computers have become more and more important in the petroleum refining industry. They are now an important factor in helping management decide refinery operations both in the present and future. This is largely because it has been found possible to simulate refinery operations through computer calculations. The effect of modifications in operating procedures can thus be studied conveniently and at low cost.

In 1954, after several years of successful experience in simulating individual processes on small and medium-scale computers, Esso Standard decided to try complete refinery simulation on a large-scale machine. The IBM Type 701 EDPM in New York was selected because it had the necessary features and was most accessible. About two and a half man years of work were spent in programming a refinery simulation model of this computer, exclusive of time spent on developing correlations and calculation methods.

Basic objectives established for the project were:

1. Simulate one specific refinery.
2. Once data are introduced for any particular problem, the computer operation should be fully automatic until the refinery is balanced.
3. The results should be at least feasible though not, in all cases, optimal.
4. All products should satisfy specifications.

The refinery simulation model was designed for use by technical people who need not be acquainted with the details of its internal operations. From the user's viewpoint, the following classes of input data must be supplied to the model for a case calculation:

1. **Crude Slate.** The machine must have the names and B/D of each crude being processed. The pipestill cutpoints at which each crude should be run must also be indicated. Later in the procedure, some of these cutpoints may be automatically revised to satisfy limiting conditions.
2. **Cracking Conditions.** The principal controllable parameters for catalytic and thermal cracking must be specified. This includes such data as reactor temperature, furnace firing rates, catalyst conditions, etc.
3. **Feed Selection Principles.** For each processing step, it is necessary to indicate which streams are potential feedstocks and a preference order for filling up each unit to capacity.
4. **Specialty Requirements.** All specialty products such as chemicals, LPG, kerosine, and diesel fuels are produced to satisfy any desired requirement. Prime fuel products are produced in, generally, unrestricted amounts. Multiple case study must be used when studying problems where these products must not exceed certain limits.
5. **Product Specifications.** Twenty-five different product quality specifications are observed by this model and must be supplied as input data.
6. **Economic Data.** This includes crude and additive costs, finished product prices, and any deviations from pre-set manufacturing cost equations.

From this information, the computer finds a feasible manner for operating the refinery so that physical limitations are observed and quality requirements are satisfied. The output data are in the following classes:

1. Yields and qualities, intermediate products

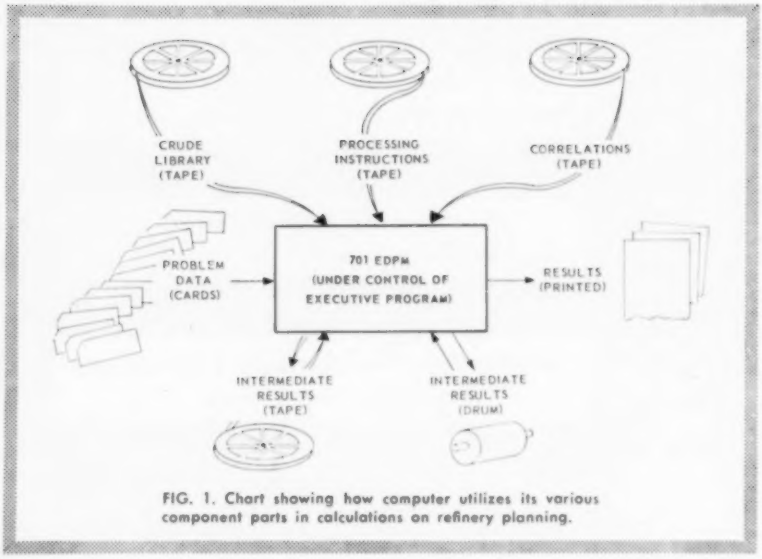
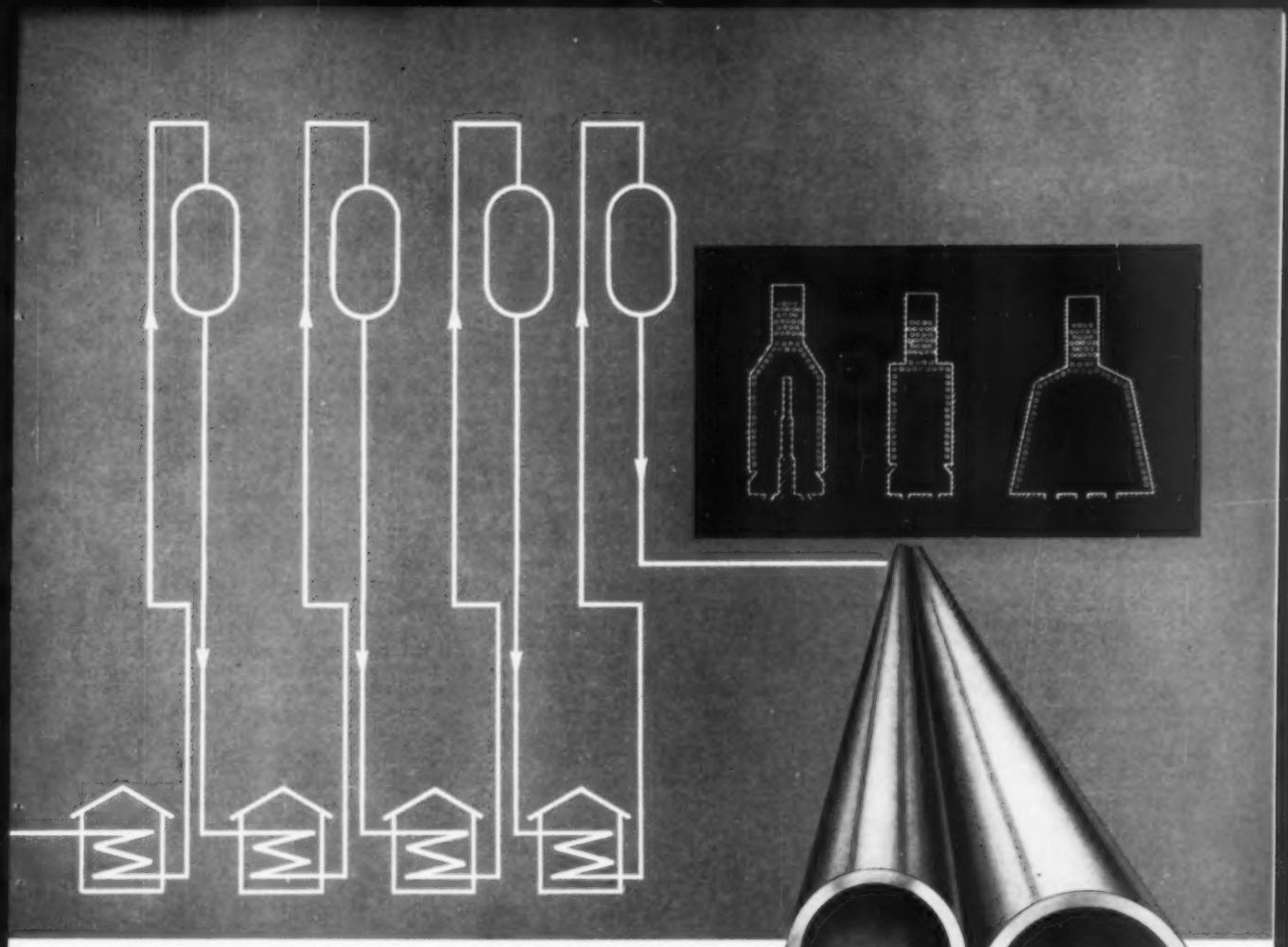


FIG. 1. Chart showing how computer utilizes its various component parts in calculations on refinery planning.



HOW MANY PROBLEMS IN THIS PICTURE?

Some layouts present a multiplicity of engineering, purchasing, warehousing and financing problems. Conceivably, (1) Return bends have to be designed for a perfect fit on their heater tubes, (2) Both tubing and fittings must meet the same exacting customer standards, (3) Simultaneous delivery must be made to guarantee erection schedules, and (4) Money tied up in material in process at any one time must be kept to a minimum.

In such a situation, it's best to depend upon Mr. Tubes for coordinated delivery of perfectly matched tubing and fittings.

Think of your own requirements in terms of the right tube for the job, tubing (or alloy pipe) and welding fittings and forged steel flanges as components of an integrated system—and you'll make B&W's Mr. Tubes a member of your team. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W

TUBULAR PRODUCTS DIVISION

TA-6085-PP

Seamless and welded tubular products, seamless welding fittings and forged steel flanges in carbon, alloy and stainless steels

2. Operating temperatures, pressures, and flow rates
3. Yields and qualities, final products
4. Profit analysis.

This computer model takes into account the manufacture of a full line of products:

1. Motor gasoline (2 grades)
2. Kerosine
3. Diesel fuels (3 grades)
4. Heating oil
5. (Net) fuel
6. Chemicals
7. LPG
8. Intermediates (sales or storage).

The procedure which the computer follows in performing these calculations involves a long sequence of steps with trial-and-error balancing to meet specified conditions. For ease in handling, this sequence is broken down into several sections. For example, the first section is concerned with distillation of virgin process streams from crudes. Another section involves catalytic cracking of all potential feed stocks. These feeds are allocated between two catalytic cracking units and cracked under conditions specified as problem data. Other later sections balance refinery gasoline and heating oil pools, producing product meeting or exceeding required specifications.

Fig. 1 shows how the computer uses its several component parts in this calculation. Data for a specific problem are read from cards. Then, under the control of a master "executive" program, data on the crudes being run are read from a crude library stored on magnetic tape. These crudes are "distilled" according to instructions drawn from a second magnetic tape. A third tape provides correlations which may be involved in the calculations. Then the executive program brings in further instructions from the second tape to do the next section of the calculations. Finally, when all calculations are complete, the results are printed.

The refinery simulation program has been used for diverse types of problems. For example, the marginal value of particular crudes has been examined. The incremental cost of meeting various product specifications has also been studied. Another case considered refinery operations during a period when one of two catalytic cracking units was down for a turnaround. Another type of investigation involved adding new process units to the refinery and studying their effects on operations.

Most of these case calculations take about twenty minutes. The exact time required is a function of the nature of the case. In any event, it is of an entirely different order of magnitude than would be required for hand calculations. This permits many alternative operations to be practically considered. In turn, the opportunity for finding improved operating practices is greatly enlarged.

It was not possible to make extensive use of the New York 701 on a routine basis. However, because of the successful experience on this calculator, Esso Standard is planning to continue its refinery simulation work on the IBM Type 705 EDPM. This machine was selected for dual use in both accounting and technical functions.

In going to the newer calculator the scope of the refinery simulation program is being enlarged. It will be general for application to several East Coast refineries. It will try to achieve more nearly optimum operating conditions. It will do much of its trial-and-error balancing in a more efficient manner.

One of the characteristics of the petroleum refining industry is that it operates in a continually changing environment. New manufacturing processes develop from an intensive research effort. Available raw materials, specifications for products and the relative demand for them, prices and costs, all change rapidly. To keep pace with this rapid change and to be able to respond to it quickly requires the help of advanced computing equipment.

P 815.7

Problems of Fuel Injection For Gasoline Engines

F. C. Mock, *Bendix Products Division, Bendix Aviation Corporation*

MUCH work has been done on fuel injection in the past. Dr. Diesel's engine patent of 1892 showed an injection pump much like those of today. The Wright Brothers' aircraft engine of 1903-1904 with spark ignition used gasoline injection into the intake manifold. There are very successful injection systems in military aircraft and on our latest big air transports today. We, therefore, have the engineering, manufacturing, and metallurgical know-how but thus far the cost has seemed prohibitive.

Condensed from a paper by the same author, presented before the Fuels and Lubricants Activity, SAE, November 9-10, 1955.

Different Injection Forms

It is first necessary to bear in mind that there are several different varieties of fuel injection, that vary in complication, cost, and the amount of operational improvement which they give.

Fig. 1 shows the most common form, a multiple unit pump that delivers individually metered and timed discharges of fuel through separate lines to each cylinder. The delivery may be into the intake ports as illustrated; or with somewhat greater difficulty and expense, the spray nozzles may discharge directly into the cylinders.

Fig. 2 shows an arrangement in which the fuel pump feeds into a continuously pressurized fuel line with delivery valves at each cylinder. In Diesel practice these delivery valves are operated by cams and camshafts along the cylinder heads, which is quite expensive. As shown in Fig. 2, the metering valves are electrically operated by solenoids; this has operated well on experimental cars.

Fig. 3 shows a sort of compromise between injection and the common carburetor, in which the fuel is pressurized by a pump, taken through a metering unit, and then sprayed at medium pressure into a center point on the intake manifolds.

It should be noted that all of these ar-

DU PONT *Petroleum Chemicals* NEWS

One of a Series of Bulletins for the Petroleum Industry

FEBRUARY 1957

Critical lubricating problems indicate growing market for estersil greases

There is a steadily growing number of industrial processes where lubricants are exposed to water and intense heat, combined with vigorous working. These applications demand lubricant performance beyond the capability of ordinary greases.

By using Du Pont Estersil GT (grease thickener), several industrial lubricant makers are meeting this demand for better greases with considerable success. Here is a typical example of how estersil can help grease suppliers meet unusually difficult lubrication requirements.

Grease life extended

A pigments manufacturer had been using a conventional grease for lubricating chemical dryer racks. This grease lost its lubricating qualities after one trip through the drying oven where the temperature averaged 120°C. This made the racks (weighing 2500 lbs.) difficult to roll manually, and resulted in excessive downtime for frequent greasing.

To increase the efficiency of this process, an estersil-based grease was tried. Success was immediate. The racks rolled easier and downtime for greasing was cut in half.

Safety increased, too

In addition to the economy realized through reduced downtime, this company got an extra dividend in increased safety. With the conventional grease, an accident occurred in which the operator's hand and wrist were jammed because the rack would not roll easily. And the danger of this—plus physical strain—occurring frequently was great. But, by making the racks roll more easily, the estersil grease eliminated this hazard.

Broad market

There are many other similar applications where greases made with Du Pont Estersil GT can best meet the critical demands of high-temperature operation, or where high water resistance is needed. They have, for example, increased efficiency in enamelling-oven conveyor setups having operating temperatures as high as 500°F.

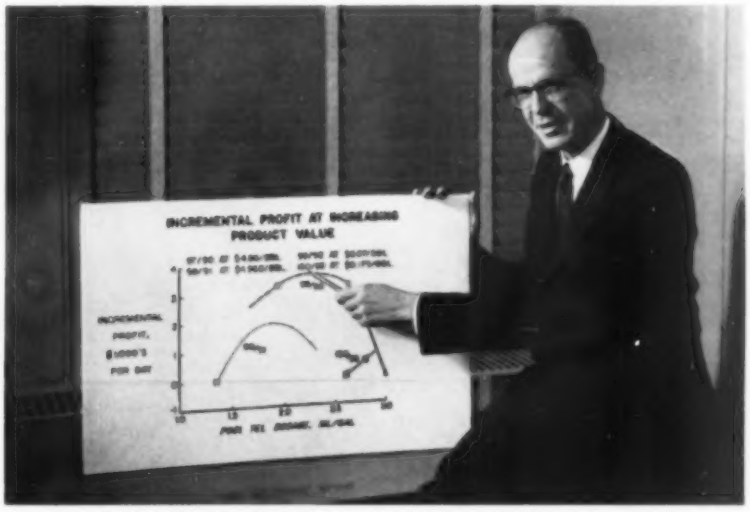
Farm tractors, mining machinery, and heavy construction equipment represent another big market for estersil-based greases. In these applications they give better protection against dirt, water and rough going . . . and help to cut maintenance costs by increasing lubrication efficiency and by reducing downtime for greasing.

Any of our sales offices will be glad to furnish more information on Du Pont Estersil GT and how it can increase grease sales and profits potential.

How economic study of operations helps increase refinery profits

by Jack S. Bellah

A modern refinery of course offers many process and gasoline blending possibilities. And selecting the combination of the variables that will produce desired product quality most economically requires a careful analysis of plant operating and laboratory blending data. Refiners who do not have their own staffs to do this work are invited to consult with Du Pont.



MANY YEARS' EXPERIENCE in refinery technology enables Mr. Bellah to make a practical, accurate economic-analysis of many refinery operations.

Those having their own economic study group may want to compare their results with ours to see if perhaps a different viewpoint can lead to further economies.

A Du Pont service

As a supplier of tetraethyl lead, we at the Du Pont Company are continuously analyzing typical refinery operations to determine their effect on the additives business. In discussing our general conclusions with people in the industry, we have been asked in several instances to make such an analysis for a specific operation. We are always glad to provide this help as a service to the refiner.

To illustrate how this service has

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OVER

REFINING IN BRIEF

DU PONT *Petroleum Chemicals* NEWS

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been used, here are the results of one such investigation:

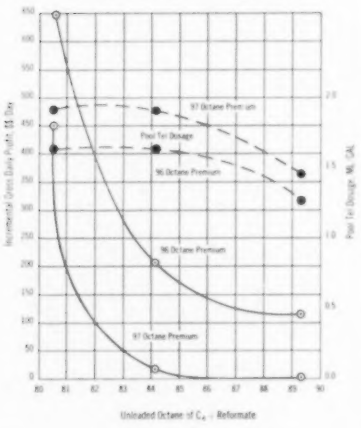
A case history

A small modern refinery recently added a catalytic reformer to the processing facilities. Three reformer operating conditions were compared—low level, design, and high level severity. A fourth case, involving jet fuel production and non-operation of the reformer, permitted calculating the break-even gross value of those gasoline components which went into the jet fuel production. Two premium gasoline octane levels also were to be considered.

The results are shown in the graph at left and in the table below.

FIGURE 1

Economic Study of Catalytic Reforming Operations



Profit up $400 per day

At the platformer design operating condition – 90% C_4 plus recovery of 84.2 clear octane product – the daily gross profit was calculated to be some $400 less than that obtained from an operation yielding 91% C_4 plus recovery of 81.1 clear octane product. This, as you can see in the table at left, was indicated at both 96 and 97 octane premium levels.

On the other hand, a disadvantage was indicated for operation at any higher severity level than the design condition. This led to the general conclusion that an even lower level of operating severity than the one estimated might be still more attractive.

Available to you

By comparing notes with you on the most economical processing steps and reforming severity, in relation to your own individual stocks and market requirements, there is a chance that we can provide a service to your own process engineering group. Just drop us a line if you would like us to discuss this service with you.

TABLE 1

Economic Study of Catalytic Reforming Operations

	Design	Lo Level	Hi Level	Down
Reformer Operation				
C_4 + Clear Research Number	84.2	81.1	89.3	Jet Fuel
Pool TEL Dosage Ml/Gal.				
96 Premium	1.625	1.65	1.275	2.685
97 Premium	1.895	1.92	1.44	2.97
Product Realization, $/CD	38880	39205	38625	30885
Variable Costs, $/CD				
96 Premium	2965	2850	2805	2965
97 Premium	3160	3045	2920	3125
Net Gross Realization, $/CD				
96 Premium	35915	36355	35820	27920
97 Premium	35720	36160	35705	27760
Incremental Gross Profit, $/CD				
96 Premium	210	650	115	
97 Premium	15	455	0	
Jet Fuel Break-Even with Best Performance Case, $/CD				
96 Premium – 11.2¢/Gal.				8435
97 Premium – 11.1¢/Gal.				8400

Residual fuel sludge problems solved with Du Pont FOA-2

At a midwestern manufacturing plant, the oil pump of an underground heavy-oil storage tank became ineffectual because of a sludge accumulation blocking the supply line. Five gallons of Fuel Oil Additive No. 2 were added to the tank, and the fuel was recirculated for several days. In this way, enough sediment was removed from the tank to permit operation of the pump.

Not only had FOA-2 dispersed the sludge—but the filters *remained* clean afterward. And the oil containing the sludge was burned in a normal manner without any harmful effect on the combustion system. Also, this simple and inexpensive method eliminated the hazardous and expensive job of lowering a man into the tank to remove the sludge mechanically.

Another FOA-2 Economy

At a New Jersey chemical plant, periodic cleaning of a heavy fuel-oil storage tank was required. In addition, large particles of solid material on the strainer before the pump caused an increase in the pump suction vacuum. On several occasions, pump suction was lost completely.

Outside service companies had previously been employed for a similar cleaning job. This time, however, it was decided to try another method. One hundred pounds of FOA-2 per 1,000 barrels were put in and the oil was recirculated.

Examination of the strainers showed no sludge-binding material. As a result, pump suction vacuum dropped to normal where it stayed. To maintain these improvements, FOA-2 is now being used regularly in a concentration of 35 pounds/1,000 barrels.

These case histories show how existing sludge problems can be easily solved and—better—prevented, through the addition of FOA-2 at the refinery.

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OVER

Serial No. A3667

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REFINING IN BRIEF

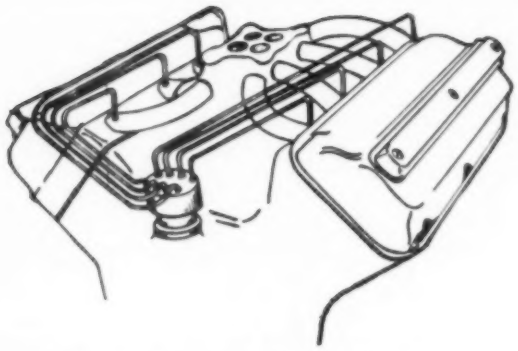


FIG. 1. System of timed injection by multiple unit pump.

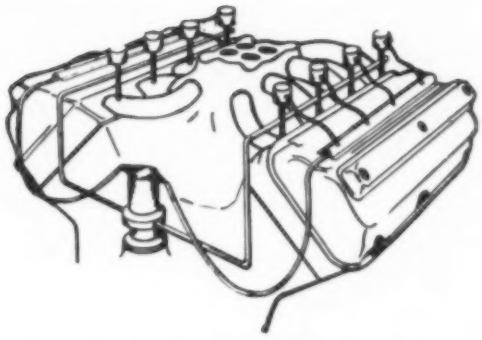


FIG. 2. Timed injection by "common rail" system.

rangements require an additional fuel pump drive on the engine; which both increases the expense and makes it impossible to install the system on present engines. Also, every one of these injection systems will require some sort of fuel metering device, throttle valves, air cleaners, and as will be brought out later, some equivalent for the present automatic choke. Further, it will probably be necessary to have a fuel supply pump mounted in or level with the bottom of the gasoline tank to overcome hot weather vapor lock.

Limitations and Advantages of Injection

Fuel injection practice for automobiles has developed rather different than with Diesel engines. For instance, it had been supposed that since the Diesel engine, with fuel injection, could operate on low volatility fuels, this also would be true with spark ignition. However, with a Diesel engine, the fuel is injected *at the top of the compression stroke* when the air in the combustion chamber is not only "thick" but also quite hot. The travel of the fuel spray is relatively short, and even heavy fuel vaporizes quickly. Because of the short time available the fuel and air do not completely mix and it is seldom possible to burn more than about 60 per cent of the air charge.

We proved this on a test engine on which it was possible to change the compression ratio and means of ignition, leaving everything else the same. With *injection near top center* of the compression stroke, with either compression ignition or spark ignition we could burn only a limited part of the fuel output from our injection pump; feeding more fuel would give no more power but would give exhaust smoke. (See Fig. 4.) But with spark ignition and *injection on the intake stroke*, we could immediately increase the fuel delivery and get more power, and no smoke. Also, we could increase the fuel delivery up to the amount the engine required with the carburetor and spark ignition; in fact, we could get a little more air into the engine than we would with the carburetor in place.

However, injection into the intake ports or engine cylinders on the intake stroke brought a new difficulty; unlike the Diesel, we were injecting into relatively cold air at atmospheric density. Hence, any fuel spray that we could use would carry right across the air space and momentarily condense on some metal wall, which might be cooler than the boiling point of the fuel. As a result, we had to use fuels with about the same volatility limits as are necessary with the carburetor. Also, we had to use either automatic chokes or priming devices for starting and warming up just as with a carburetor. Nevertheless, all experimenters seem to agree that injection gives certain definite advantages.

1. More power both at low and high speeds.

2. If properly built, it shows a lower, smoother, and more stable idle; which is a marked advantage with our

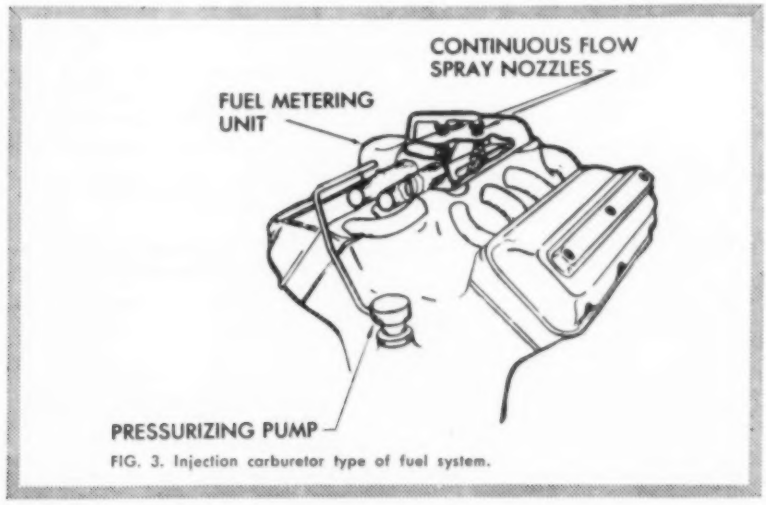


FIG. 3. Injection carburetor type of fuel system.

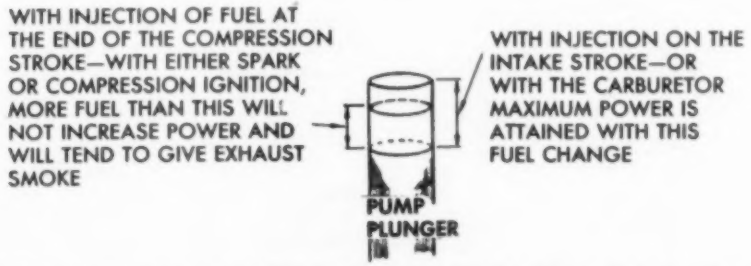

WITH INJECTION OF FUEL AT THE END OF THE COMPRESSION STROKE—WITH EITHER SPARK OR COMPRESSION IGNITION, MORE FUEL THAN THIS WILL NOT INCREASE POWER AND WILL TEND TO GIVE EXHAUST SMOKE
WITH INJECTION ON THE INTAKE STROKE—OR WITH THE CARBURETOR MAXIMUM POWER IS ATTAINED WITH THIS FUEL CHANGE
PUMP PLUNGER

FIG. 4. Diagram showing limits of fuel charge that can be burned in a given cylinder with varying times for mixing.

hydraulic transmission in reducing the tendency to "creep."

3. It becomes possible to eliminate most of the toxic, evil-smelling and eye-smarting gasses that come out of the exhaust when idling or coasting.

4. For continued heavy duty or for racing cars, injection into the cylinder has the important advantage of greatly reducing the tendency to pre-ignition and back-firing, when the power is so great that the spark plug points are continuously white hot.

5. Thus far, it is unsettled whether or not there is an appreciable gain in fuel economy with injection; also whether higher compressions can be used.

Use of High Volatility Fuels

If and when fuel injection is introduced, there will probably be a demand for handling lighter volatility fuels, which will certainly tend to boil out of the pump and fuel lines during the "heat soak" when the engine is stopped after a hard run. However, we can learn from our aircraft altitude experience and apply the following improvements.

1. As previously mentioned, have a supply boost pump at the bottom of the main fuel tank.

2. Provide vapor vents as necessary, delivering into a by-pass line from the fuel pump back to the tank. This will both take out bubbles and keep the system cool.

3. Use of high pressure discharge nozzles will keep the pressure up in the whole fuel system from the injection pump on and thereby delay the onset of boiling.

Conclusions

In view of the inevitably higher cost of fuel injection, it seems certain that it will come first on the more expensive cars; and also in different forms, according to the deficiencies of the existing carburetor system.

A. For racing cars, injection like Fig. 1 or Fig. 2 *into the cylinders* will be required to avoid pre-ignition from hot spark plugs.

B. For truck engines or executive aircraft engines, with long intake manifolds, some form of Fig. 1 or Fig. 2 will be necessary.

C. For the 8-Cylinder V-engines where fuel distribution with the carburetor is already quite good, injection forms like Fig. 1 or Fig. 2 may come into use for the higher priced cars; while the Fig. 3 may prove a useful compromise for the lower priced cars.

It should not be forgotten that present carburetors are tremendously reliable; therefore *the first requirement for adoption of any injection system for passenger cars is reliability*, and the cost dare not be reduced below limits of secure operation. ★ ★ ★

P 762.1

Design and Application of CO BOILERS

E. Durham
and M. B. Leland
Boiler Division, Babcock & Wilcox Company

THE increase in refinery fuel costs from near give-away prices for natural gas to 8, 12 and now 15 cents a million Btu, and the parallel rise in fuel oil prices to about 35 cents a million Btu, resulted in the investigation of the possibility of generating steam from

Condensed by the authors from the paper of the same title, given before the Sabine Section, ASME, March 7, 1956.

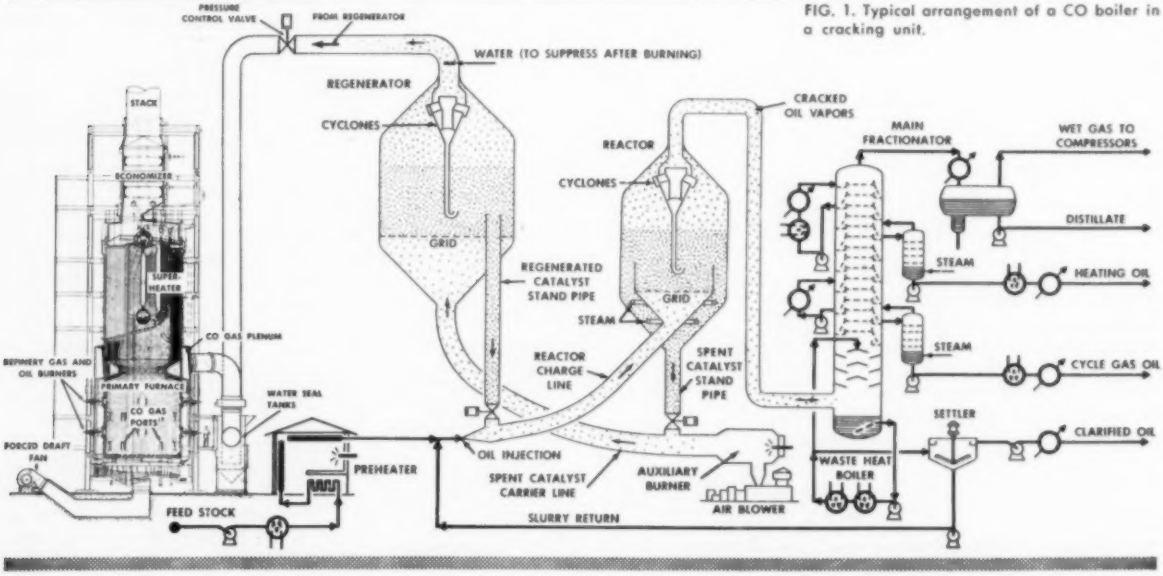
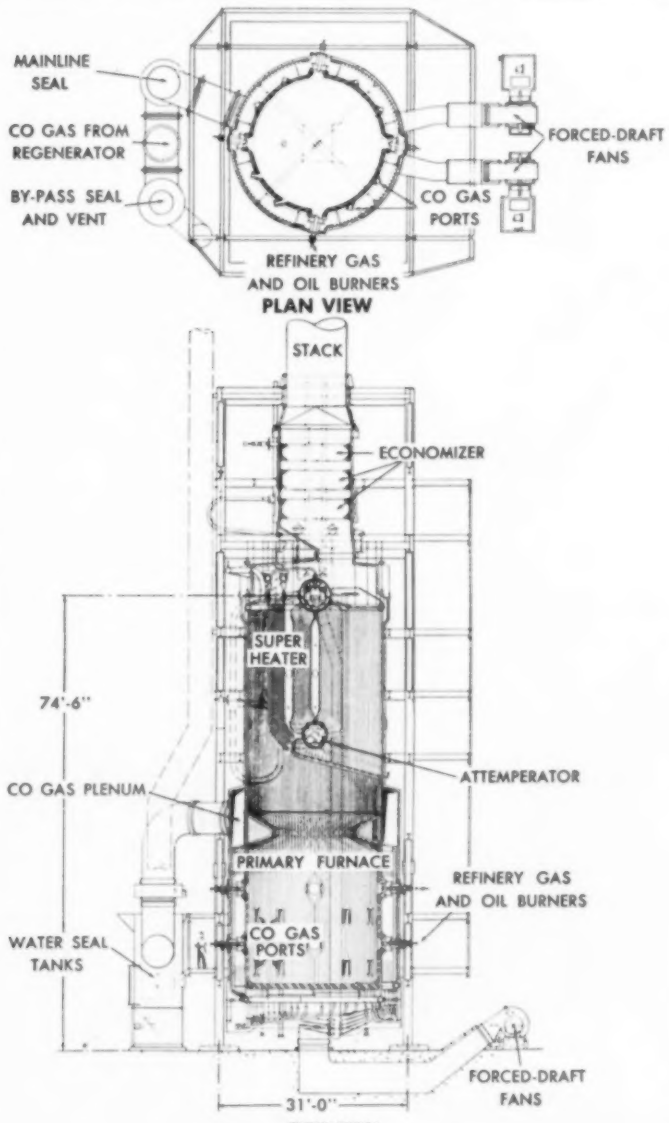


FIG. 1. Typical arrangement of a CO boiler in a cracking unit.

the large amounts of energy available in catalytic cracking unit exhaust gas streams.

The CO boiler was developed to recover the heat in the gas streams exhausting from catalytic cracking unit regenerators. These gases leave the regenerators at about 1000F, which provides approximately 145 Btu of sensible heat per pounds of gas for steam generation. The combustible in the CO gas stream is a result of the burning of the carbon coated on the cracking catalyst with, in most instances, a deficiency of air.

The CO boiler furnaces are especially designed to completely burn the combustibles in the CO gas stream. These combustibles are ignited by burning sufficient supplementary fuel to give 1800F furnace temperature after the products of combustion from the supplementary fuel and the CO gas and its oxidation air are mixed thoroughly in the refractory lined CO boiler furnace. Experience has shown that the supplementary fuel must be completely burned as quickly as possible to assure stable ignition of the relatively low temperature-low Btu CO gases.



CIRCULAR FURNACE BOILER
Sinclair Refining Company
East Chicago, Indiana

Steam capacity, lb per hr	275,000
Steam pressure, superheater outlet, psi	565
Steam temperature, F	750
CO gas flow, lb per hr	474,000
CO gas temperature, F	500

FIG. 2. Enlarged view of the CO boiler.

The first CO boiler installation was the Sinclair unit at Houston, Texas, in 1953, followed in rapid succession by Sun Oil's first CO boiler at Toledo, Ohio, and Richfield's CO boiler at Wilmington, California. The successful operation of these units has resulted in general acceptance of the CO boiler by the *oil industry* so that today, there are approximately 20 units installed or on order.

Fig. 1 illustrates a typical arrangement of a cracking unit with a CO boiler. Fig. 2 is an enlarged view of the CO boiler.

To provide for the independent operation of the CO boiler without interfering with the operation of the cracking unit, an important arrangement feature of the CO boiler, water seal tanks (valves) are installed so that the regenerator gases may be directed through the boiler or bypassed around the boiler directly to the stack. Water seal tanks are preferred to mechanical shutoff dampers or valves because of the high gas temperature, the size of valve that would be required and the necessity of having a leak-proof, nonerosive arrangement.

The operation of the CO boiler is coordinated with the operation of the catalytic cracking unit, however, steam is available from the CO boiler whether or not the cracking unit is in operation. Normally, the boiler is required to supply steam for the operation of the cracking unit and is started ahead of time using supplementary fuel only when CO gas is not available from the cracking unit. The same procedure is frequently followed when the cracking unit is being shut down.

The CO boiler is normally base loaded. Usually, there are only slight variations in the operation of the catalytic cracking unit. The CO boiler handles all the gases from the regenerator regardless of the variation in the combustible content of the CO gas stream. A change in the combustible coming from the catalytic cracking unit merely affects the amount of supplementary fuel necessary to maintain the required furnace temperature. The 1800F furnace temperature provides a reasonable operating margin for possible variations in the operation of the regenerator or the boiler.

Another application is the Oxy-Catalyst CO boiler where, in place of supplementary fuel burners, an oxidiz-

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FLUID CATALYTIC CRACKING, developed to produce greater yields of liquid products and higher octane number gasoline.

PLATFORMING, with which UOP pioneered the use of platinum in a reforming catalyst and originated the commercial designs of catalytic reforming units.

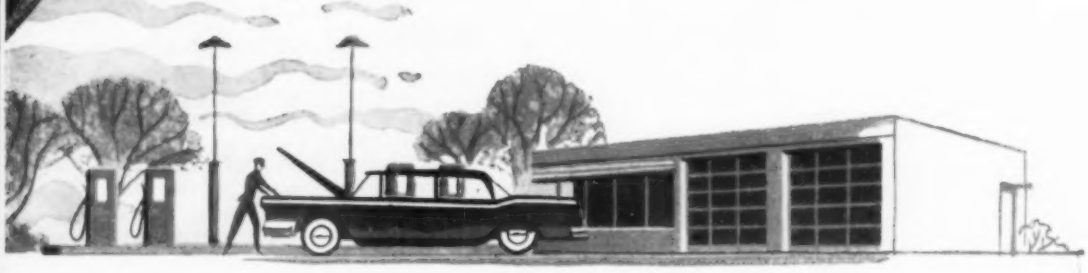
REXFORMING, a combination of UOP Platforming with solvent extraction which permits a refiner to produce even higher octane gasolines.

PENEX, a process which converts the low octane straight chain pentane and hexane fractions into the much higher isocompounds.

"HF" ALKYLATION, a process developed by UOP for producing alkylate, a high octane gasoline blending component, using hydrofluoric acid as the catalyst.

UNIFINING, the process which employs by-product hydrogen from UOP Platforming units to remove sulfur, nitrogen, oxygen and metallic impurities from petroleum distillates by catalytic hydrogenation.

These and other UOP processes, individually or collectively, can provide the answer to most refining problems. We will be glad to tell you how they can help with yours.



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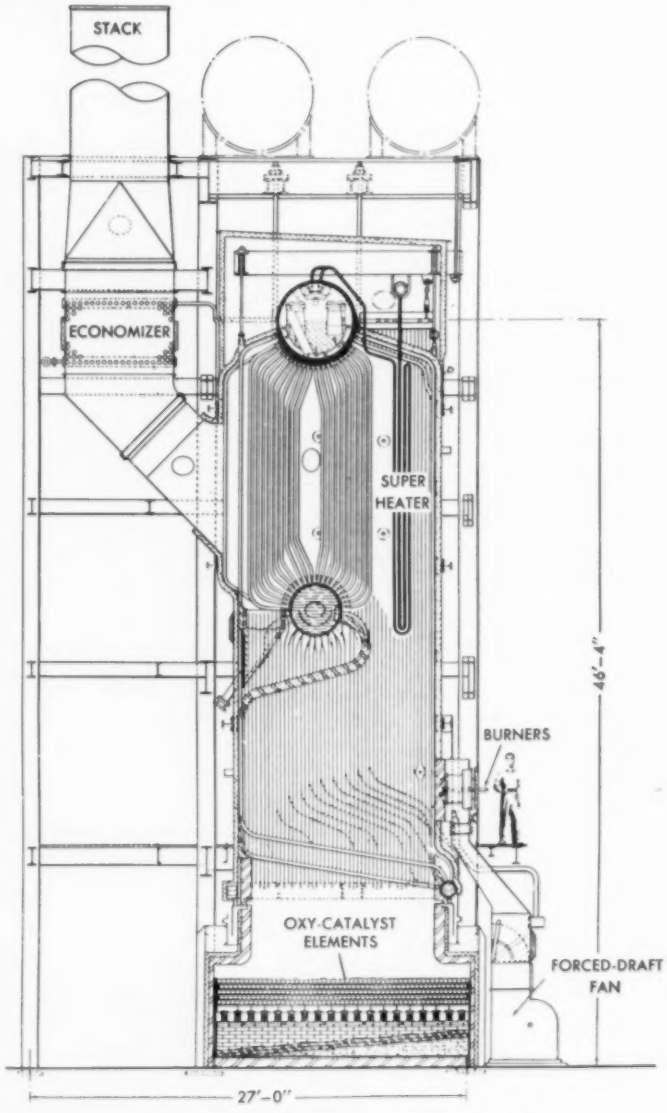

SECTIONAL VIEW OF THE OXY-CATALYST BOILERS AT SUN OIL COMPANY

	Toledo, Ohio Marcus Hook, Pennsylvania
Steam capacity, lb per hr	60,000
Steam pressure, superheater outlet, psi	450
Steam temperature, F	550
CO gas flow, lb per hr	216,000
CO gas temperature, F	850

FIG. 3. Outline of the Oxy-Catalyst boiler at Sun Oil Company's Marcus Hook, also Toledo refineries.

ing catalyst is used for releasing the heat of combustibles in the CO gas stream. With this arrangement, supplementary fuel is not required for normal operation but, because steam is required for starting the cracking unit, the boiler is equipped with a water cooled furnace and fuel burners so that the unit can be operated as a conventional power boiler when CO gas is not available. Sun Oil Company has two units of this type in operation, illustrated by Fig. 3 — one in Toledo, making two CO boilers installed at Toledo, and one at Marcus Hook.

Many oil companies find that if additional steam is required to operate the refinery, the difference in cost between a normal power boiler and a CO boiler can be quickly paid off by the fuel saved due to burning CO gas. The payoff time, of course, depends on the amount of heat available for recovery and the prevailing fuel cost in the area.

The CO boiler has proven itself an independent and reliable source of steam for refinery work during more than eight boiler-years of successful operating experience. The CO boiler is available to supply steam when the cracking unit is in operation with CO gas supplying its portion of fuel or when the cracking unit is shut down and the CO boiler is operated as a power boiler burning only supplementary fuel. ★ ★ ★

Recently spotted on the 'ole' bulletin board . . .

To all Refinery Employees:

Subject: STANDARD PROCEDURE INSTRUCTIONS ON DEATH OF EMPLOYEE

It has been recently brought to the attention of this office that many employees have been dying while on duty for apparently no good reason at all. Furthermore, the same employees are refusing to fall over after they are dead.

This Practice Must Stop at Once.

On or after January 1, 1957, any employee found sitting up after he or she has died will be dropped from the payroll at once.

Where it can be proven that the employee is being held up by a desk, drafting table, typewriter or any other support which is the property of the company, a 90-day period of grace will be granted.

The following procedure will be strictly adhered to:

If, after several hours, it is noticed than an employee has not moved or changed position, the department head will investigate. Because of the highly sensitive nature of our employees, and the close resemblance between death and their natural working attitude, the investigation will be made quietly, so as to prevent waking the employee if he is asleep. If some doubt exists as to his true condition, extending a paycheck is a fine test. If the employee does not reach for it, it may be reasonably assumed that he is dead. (Note: In some cases, the instinct is so strongly developed, however, that a spasmodic clutch reflex action may occur. Don't let it fool you.)

In all cases, a sworn statement by the dead person must be filled out on a special form provided for this purpose.

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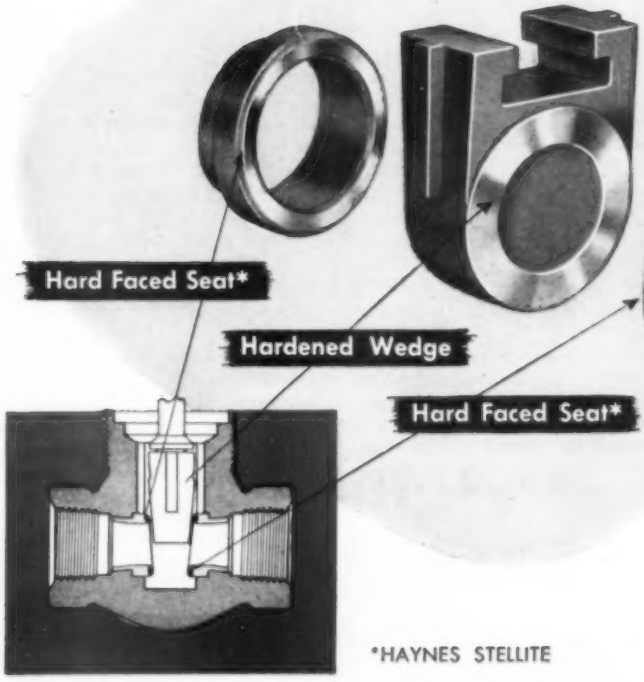

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Ultraforming

To 100 Octane Number, Clear

W. F. Johnston[1]
W. J. Montgomery[1]
and P. C. White[2]
[1]*American Oil Company, Texas City, Texas*
[2]*Standard Oil Company (Indiana) Whiting, Indiana*

Operating experience on one of the first regenerative-type catalytic reforming units to be put into operation

WITHIN the past two years, several new refining processes have been developed and have been publicized as means for breaking the "octane barrier"; that is, producing 100 Research clear gasoline or better. American Oil Company's Texas City Ultraformer is one of the few commercial units, perhaps the only unit, actually operating to produce continuously 100 octane number clear gasoline. Blending components of the highest octane number are required at this refinery for the production of the company's unique premium gasoline, unleaded Amoco. Hence, when it became necessary to select a new reforming process for the refinery, the Ultraforming process was chosen in order to provide the maximum octane product. The Amoco Ultraformer is the largest built to date, having a design charge rate of 21,200 B/SD. It was first brought on stream on February 26, 1955.

Process Description

The Ultraforming process is a fixed-bed multireactor catalytic reforming process in which low octane number naphtha is upgraded to produce high octane gasoline. A superior yield-octane relationship is obtained by operating at low pressures and by using a highly selective platinum-on-alumina catalyst developed by Standard Oil Company (Indiana).

In all platinum-reforming processes, gasoline yields increase considerably at lower reactor pressures. However, the coke yield increases rapidly as the pressure is reduced. Since coke deposition causes catalyst deactivation, early platinum-reforming processes were forced to operate at high pressures (in the range of 600 psig) in order to maintain reasonable catalyst activity. The Ultraforming process operates at the relatively low pressure of about 300 psig and is thus able to achieve much higher gasoline yields. Catalyst activity is maintained through the cyclic regeneration of the reactors. As each reactor becomes deactivated, it is replaced by a swing reactor and regenerated while the other reactors remain in process service. The regeneration process goes beyond the mere removal of coke from the catalyst. A special regeneration technique maintains the catalyst at a high activity level, even after many regeneration cycles.

The Texas City Ultraformer has six reactors, five reactors of which are on process at one time. The sixth, called the swing reactor, is used as a substitute for any of the other five during their regeneration. The complete regeneration cycle consists of a number of sequential operations requiring about 20 hours for completion. These operations are performed automatically through the operation of double-disc motor-operated valves, the movements of which are controlled by a master cycle timer.

Early Unit Operation

A major problem in the early unit operation was that of corrosion. The unit was operated initially with an undesulfurized feed containing 250 to 300 ppm sulfur. After about 1500 hours of operation, it became necessary to shut the unit down because of hot surface tubes and increasing reactor pressure drops. Inspection revealed up to ⅛-in. of iron sulfide scale in the furnace tubes, representing corrosion rates of 50 to 150 mils per year. Some of the scale had carried into the reactors and plugged the catalyst beds. This corrosion resulted from sulfur in the feed and is now known to be a problem common to all platinum catalyst reforming processes.

In order to eliminate further sulfide attack in the Texas City Ultraformer, an existing fixed-bed hydroforming unit was revamped to hydrodesulfurize the naphtha feed. The Ultraformer was shut down for inspection after 2300 hours operation on desulfurized feed; corrosion was found to be negligible.

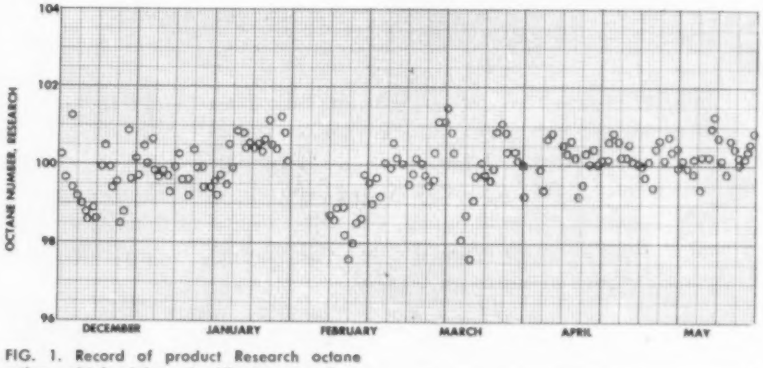

FIG. 1. Record of product Research octane ratings, obtained from the Ultraformer unit.

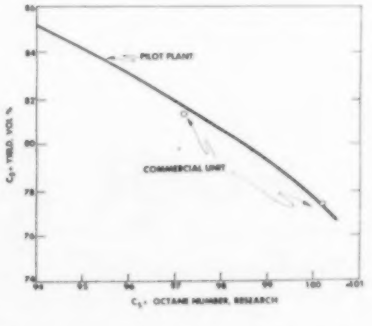

FIG. 2. Comparison of commercial and pilot plant yields for Ultraforming.

Condensed from the paper by the same authors, presented before API's Refining Division, May, 1956, Montreal, Canada.

An empty bottle . . .

clue to deposit-free heating and diesel fuels

In Du Pont Fuel Oil Additive No. 2 (FOA-2) you'll find not only an effective stabilizer and sludge dispersant, but an additive that's *ashless*.

The above picture shows the amount of ash left after burning four different additives. The bottle on the left contains the almost invisible amount of ash that would remain after burning 1,000 gallons of fuel oil containing Du Pont FOA-2—at a concentration of 20 pounds per 1,000 barrels. The other bottles contain the ash left from burning a cost-equivalent concentration of fuel-oil additives having metallic components.

Why use an ashless additive?

In the operation of oil burners or diesel engines, ash deposits can obviously interfere with proper functioning. For example, stack-control failures—brought about by metallic ash deposits on a helical coil—can lead to needless and unprofitable service calls.

Examination of many diesel locomotive exhaust-stack accumulations shows them to be composed largely of metallic ash . . . up to 98.7 wt.%. This creates a sparking hazard. However, when FOA-2 is used to prevent injector sticking and filter plugging in economy diesel fuels, the additive does not contribute to this hazard.

Write to any of our offices listed at right for further details about this versatile ashless additive.

SALES OFFICES

Chicago 3, 8 So. Michigan Ave. ..... RAndolph 6-8630
Cleveland 15, 25 Prospect Ave. ..... SUperior 1-1363
Houston 2, 705 Bank of Commerce Bldg., CApitol 5-1151
Los Angeles 17, 612 So. Flower St. ... MAdison 5-1691
New York 20,
1270 Ave. of the Americas ..... COlumbus 5-2342
Philadelphia 2, 3 Penn Center Plaza .... LOcust 8-3531
Pittsburgh 22, 1 Gateway Center ..... ATlantic 1-2933
San Francisco 4, 111 Sutter St. ..... EXbrook 2-6230
Seattle 3, 4003 Aurora Ave. ..... MElrose 6977
Tulsa 1, 1811 So. Baltimore Ave. ..... LUther 5-5578
In Canada—Du Pont Company of Canada (1956) Limited, Petroleum Chemicals, 85 Eglinton Ave. East, Toronto 12, Ontario ..... HUdson 1-6461
In Other Countries—Petroleum Chemicals Division, Export Sales, 7496 Nemours Bldg., Wilmington 98, Del., OLympia 4-5121, Ext. 2962

DU PONT
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Better Things for Better Living
. . . *through Chemistry*

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & CO. (INC.) • Petroleum Chemicals Division • Wilmington 98, Delaware

Current Unit Operation

Feed stock. The charge to the commercial unit is a mixture of virgin naphtha derived from Gulf Coast, East Texas, and West Texas sweet crudes. It is an excellent reforming charge stock containing 53 vol per cent naphthalenes and 14 vol per cent aromatics. The ASTM distillation range is 200 to 400 F and the Research octane number is 51.

Octane number and catalyst activity. In Fig. 1, a plot of the Research octane number of the debutanized 400 F ASTM FBP reformate for the months of December, 1955 through May, 1956 is presented. The octane maintenance has been very good. The slight declines in reformate octane number resulted from regeneration system shutdowns due to mechanical difficulties. At the high severity necessary for 100 octane operations, coke lay-down is such that a very slight octane fluctuation occurs which depends on the regeneration sequence. At the current severity level, it is necessary to regenerate the reactors frequently in order to maintain a high catalyst activity. On the average, about one reactor per day is regenerated.

At the present high severity operation, a catalyst life of at least 60 bbl of charge per pound of catalyst is expected. The present charge of catalyst has undergone an average of 65 regenerations per reactor and has achieved a life of 22 bbl of charge per pound of catalyst.

Yields. The commercial unit yields at 10 octane are:

Hydrogen, wt per cent	2.1
Dry Gas, wt per cent	10.3
Butane, vol per cent	7.5
C_5 + Reformate, vol per cent	77.7

These yields agree very well with pilot plant data. In Fig. 2, a comparison of commercial unit reformate yields at two octane levels with the yield octane curve obtained from pilot plant data is presented. Recent pilot plant developments have shown that operation under somewhat modified conditions will result in a reformate yield increase of 3-3.5 vol per cent. Modification of the commercial unit to realize this further yield advantage is planned.

Other pilot plant studies are continuing on the operation conditions, regeneration, the effect of feed stocks, etc. Yields have been obtained on stocks ranging from thermally cracked naphtha to Tia Juana and Mid-Continent virgin naphthas. These studies, both at American Oil Company and in the laboratories of Standard Oil Company (Indiana), are being made in order to define the best processing conditions for new feed stocks and to evaluate additional catalyst developments.

Conclusions

The Amoco Ultraformer has been in operation for over a year now and through sustained operation has proven the ability of the Ultraforming process to produce 100 octane number clear gasoline. With direct operating costs of only 25 cents per bbl, it is an economical process. The installation of a second Ultraformer at American Oil Company's new Yorktown, Virginia, refinery attests to the fact that Amoco believes this to be the top process for 100 octane operation.

References

1. Standard Oil Company (Indiana): "Ultraforming," *Petroleum Refiner 33*, No. 9, page 162 (1954).
2. Forrester, Conn, and Malloy: "Ultraforming —New Reforming Process," *Petroleum Refiner 33*, No. 4, pages 153-156 (1954).

P 624.57

The Diatometer

A Method for Indicating Conditions of Aquatic Life

M. H. Hohn

Academy of Natural Sciences, Philadelphia, Pennsylvania

THE many river surveys conducted at the Academy of National Sciences of Philadelphia have shown that the best measure of the effect of pollution on the aquatic life of a natural river is one based on all kinds of aquatic life. Some of the results of such studies, giving both a qualitative and quantitative measure, can be graphically expressed by the use of histograms (Fig. 1).

The heights of the various columns represent the number of species as compared with the number found in a natural river of similar type. The average number found in natural rivers is set as equal to 100 per cent. The width of the column represents the relative abundance of the various groups. A double-width column indicates the species represented by that column were very abundant, while a white column indicates the species were very scarce.

The columns represent the following groups of species: Column I, algae and rotifers tolerant of pollution; Column II, worms and other invertebrates tolerant of pollution; Column III, protozoa; Column IV, algae not in Column I, mostly diatoms; Column V, all lower invertebrates execept those included in Column II and the rotifiers in Column I; Column VI, all arthropods; Column VII, all fish.

The effect of pollution is shown by a reduction in the number of non-tolerant species that reduces the height of the column in the histogram. As the pollution becomes more severe certain columns may be eliminated entirely. The effect of the pollution on the river can be measured by the per cent reduction in the species that go to make up the height of the columns.

In the development of these methods one problem constantly presented itself: Could one find a relatively simple method of continually recording the condition of a river? Such a method must use a group of organisms which has species that can live in polluted conditions as well as those which are sensitive to pollution. Specimens must

Condensation of a talk presented to a session on waste disposal during the 21st Midyear Meeting of the American Petroleum Institute's Division of Refining, in the Sheraton-Mount Royal Hotel, Montreal, Que., Canada, May 16, 1956.

Inside Story on POWELL PETROLEUM VALVES

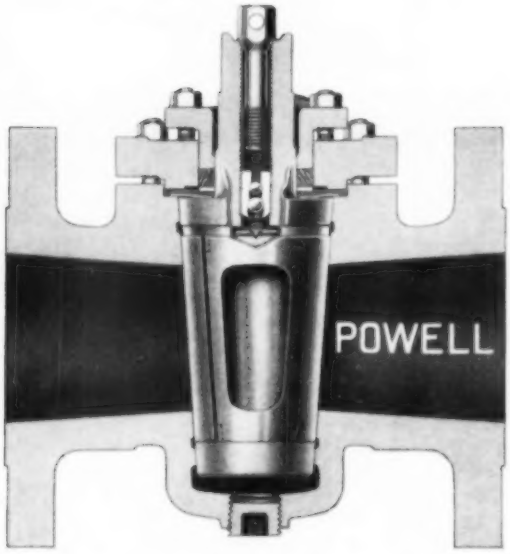

FIG. 2201 (Sectional) -- 200-Pound W.O.G. Semi-Steel Lubricated Plug Valve

Petroleum valves may appear to be alike on the outside. But inside -- in materials, in design, in manufacture -- there can be a world of difference. And the inside story on Powell Petroleum Valves is that every valve has PERFORMANCE VERIFIED.

Only the finest materials are used in Powell Petroleum Valves, and painstaking quality control is rigidly enforced through each step of manufacture

As a final step in manufacture, every Powell Petroleum Valve is subjected to an ACTUAL LINE TEST. Because of Powell's quality control, valve failure is practically unknown. Records from the world over prove it.

Valve users who want one source of supply for Lubricated Plug as well as all types of bronze, iron, steel and corrosion-resistant valves will want full details on Powell Petroleum Valves

Available through distributors in principal cities. If none is located near you -- or if you need help on valve problems -- write direct to The Wm. Powell Company, Cincinnati 22, Ohio.

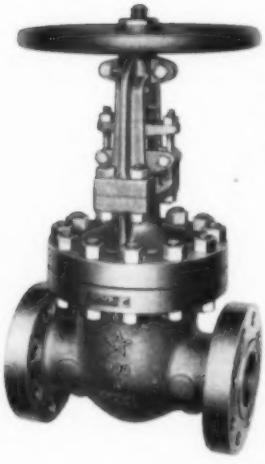

FIG. 9003 -- 900-Pound Steel O.S. and Y. Gate Valve Bolted Flanged Bonnet

FIG. 3061 -- 300-Pound Steel Swing Check Valve

PERFORMANCE PV VERIFIED

The Wm. Powell Company, Cincinnati 22, Ohio . . . 111th YEAR

POWELL VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES

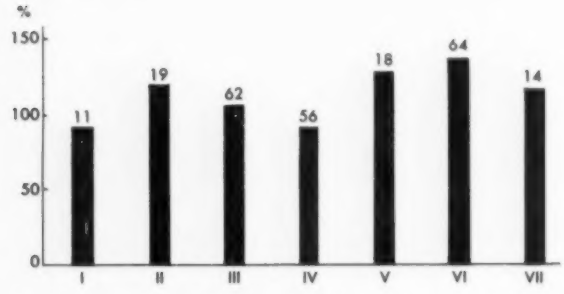

FIG. 1. Histogram for a healthy river.

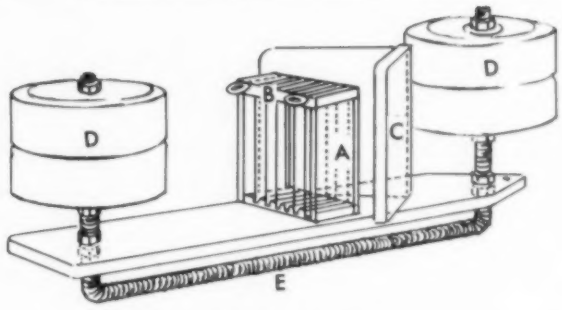

FIG. 2. The Diatometer.

be easy to collect and preserve for they must provide a tangible permanent record. The diatoms seemed to be the most logical choice for the following reasons:

1. They need no special treatment for preservation because the cell wall, on which identification is based, is composed of silica.

2. The diatom flora of a normal stream is made up of a great many species represented by many specimens. Thus, the group lends itself to statistical treatment.

3. A great deal is known about the sensitivity of various species to certain ecological conditions.

4. Some species of this group are very sensitive to environmental changes, while others are very tolerant.

An apparatus (Fig. 2) was devised which would continually sample the diatom flora of a river. Since diatoms are photosynthetic, it has to float. The slides are held in a vertical position to prevent deposition of silt on the diatoms. The Diatometer can be anchored in place and slides removed at regular intervals and examined. A cursory or a detailed reading can be made of these slides as a means of comparing water conditions in any given area.

From the data supplied by a detailed reading, a truncated normal curve can be constructed. The method of constructing this curve as well as the theoretical aspects and the reliability of this apparatus for sampling a diatom population are described in a paper by Patrick, Hohn and Wallace.*

Areas in a body of water may be compared one with the other on the basis of the height of the mode, the number of intervals covered by the curves, the total number of observed species, the species present in the theoretical universe and the total of specimens counted in order to construct the curve.

The diatom population for an estuary on the Atlantic Coast not adversely affected by pollution is given in Fig. 3. The effect of pollution on the structure of the diatom population from a similar area is shown in Fig. 4. In the latter case the number of species in the mode was reduced by more than 50 per cent. The number of observed species and species present in the theoretical universe were similarly reduced. The curve, due to an overabundance of a few tolerant species, covered 14 intervals instead of 11 intervals as was found in water not adversely affected by pollution.

Studies on polluted and non-polluted areas have been made on the Atlantic Coast in Chesapeake Bay and the Lewes-Rehoboth Canal; on the Gulf Coast in Galveston Bay, Houston Ship Channel and Chocolate Bay. The results of these studies show that the Diatometer is effective in indicating pollution in bays, estuaries and ship channels. The pattern of these results is very comparable with the results of similar studies on fresh-water rivers. The main differences lie in the fact that the height of the mode is slightly lower. The number of species in the total population is also a little less.

Diatometers in large numbers may be used to chart the pollution pattern in bays and estuaries. By placing Diatometers in a concentric pattern from the source of pollution out into the bay or estuary, the area affected by the pollution can be determined accurately. Such studies have been carried out in Patapsco Bay and Galveston Bay.

*Ruth Patrick, Matthew H. Hohn, and John H. Wallace. "A new method for determining the pattern of the diatom flora." Not. Nat. Acad. Nat. Sci. Phila. No. 259. 12 pp. 1954.

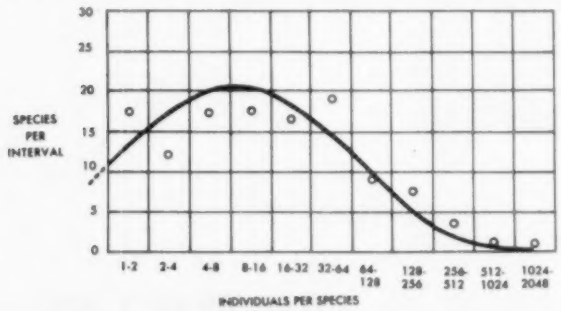

FIG. 3. Graph of a diatom population from an estuary on the Atlantic Coast not adversely affected by pollution.

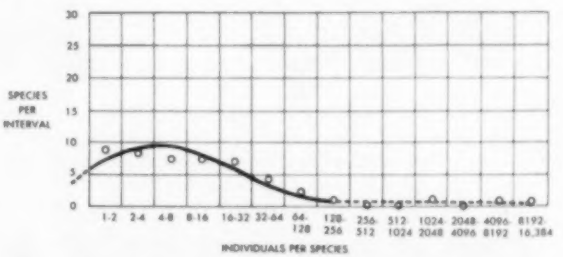

FIG. 4. Graph of a diatom population from a bay on the Atlantic Coast showing severe effect of pollution.

Scope and Administration of Preventive Maintenance

P 937.

C. C. Carmine
Tidewater Oil Company, Associated, California

ONE of the basic problems in an oil refinery is to develop a program that will maintain the plant at optimum cost; i.e., the most favorable cost-all factors considered.

A preventive maintenance program attempts to solve the problem by providing for the planning and scheduling of the following: (1) routine inspections while equipment is operating; (2) short-term shutdowns or outages for the purpose of inspection and minor maintenance; and (3) overhauls. It is solved if, through the inauguration of such a program, the prevention of unscheduled breakdowns of uncertain duration and seriousness results in decreased operating costs, increased production, and added protection to capital investment.

Scope of Preventive Maintenance

It is suggested that the scope of a preventive maintenance program includes a consideration of many factors including those listed and described briefly below.

1. *Design and Material Controls*

Preventing excessive maintenance begins with design where due consideration is given to accessibility for inspection and repairs, standardization and interchangeability of parts, predicted operating conditions with respect to overloads, and requirements for protection against erosion and corrosion.

2. *Operating Procedures*

Written standard operating instructions are required, providing for: starting up, continuous operation, shutting down, lubrication, emergencies, testing, inspections, and overhauls.

3. *Records*

Maintenance-record cards are set up for all major pieces of identifiable equipment throughout the plant. These cards are used to record the cost of maintenance being incurred on a piece of equipment **and are used as a guide for investigating excessive maintenance.**

4. *The Extent of the Program*

This is established by a study to determine what equipment is to be placed under a preventive maintenance program and scheduled for inspection, routine maintenance, and overhaul. The savings in preventing a breakdown furnish the criterion for inclusion in the program.

5. *The Accounting System*

A preventive maintenance program requires an adequate accounting system that will render current returns on the cost of administering the program and on the cost of maintaining each piece of equipment included in it.

6. *Maintenance Organization and Procedures*

The next step is to set up a maintenance-control system embracing: (1) an organization that provides for the planning and scheduling of inspection and maintenance; (2) procedures for having the inspection and maintenance work performed.

The inspection branch of the organization sets up inspection schedules and check lists based on such factors as safety-code requirements, local standards, allowable tolerances, and test results.

The planning and scheduling branch operates under a formal, written work-order system. All work to be performed is authorized through the medium of written job orders that are planned in detail and then scheduled on a daily, weekly, or long-range basis.

Field execution performs the work as planned and scheduled and provides for the proper organization of the maintenance force including: (1) the necessary quantity and quality of field supervision; (2) adequate skilled, semi-skilled, and unskilled labor; (3) the satisfactory division of labor; (4) the proper tools and equipment.

7. *Reports*

Cost and activity reports are issued periodically for the review of all concerned. They should be brief, clear and current.

The maintenance-record card is one currently maintained report which is of great value in the preventive maintenance program.

Activity reports include periodic inspection reports of the physical con-

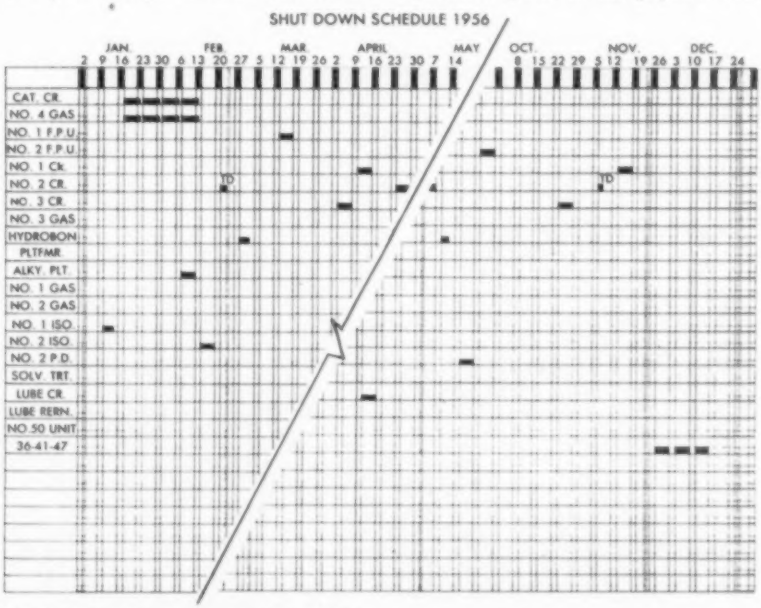

FIG. 1. Typical process unit shutdown schedule.

Complete paper presented to a session on refinery maintenance during the twenty-first mid-year meeting of the American Petroleum Institute's Division of Refining at Montreal, Canada, May 15, 1956.

dition of equipment and form the basis for planning and authorizing work to be performed.

A type of report combining both cost and activity would be one following a breakdown. The cost of repairing the facility or equipment which had failed, and the value of production lost as a result of the breakdown, would be determined and evaluated with respect to the type of preventive maintenance program, if any, in effect.

8. *Quality of Personnel*

To carry out a satisfactory preventive maintenance program trained supervisors, inspectors, engineers, and mechanics are required.

The engineer, trained in the "scientific aproach," is needed in the program for such activities as: Setting up the system of record keeping; establishing inspection and lubrication schedules; determining the critical equipment and spare parts to be carried; writing procedures; appraising maintenance performance with respect to design; diagnosing equipment failures; studying job methods; assisting in a standardization program.

Tidewater Oil's Avon Refinery

Tidewater Oil Company's refinery at Avon, California (approximately 30 miles east of San Francisco) is an integrated oil refinery with a present crude-oil throughput capacity of 110,000 bbl per day. Twenty-five different kinds of light and heavy crude oil are run with sulfur content ranging up to seven per cent.

The maintenance force is relatively fixed in size and is augmented, for peak-maintenance load conditions during shutdowns of the very large units by outside contractors.

The refinery is divided geographically into three maintenance zones.

Avon Refinery's Preventive Maintenance Program

Avon refinery has adopted and is administering certain portions of the overall scope of a preventive maintenance program as described below.

Plant Inspection

Avon has an independent plant inspection group who have two main functions: (1) The non-destructive inspection of existing static structures for conformance to safety-code requirements for evidences of corrosion or erosion, for indications of fatigue, and for general physical conditions; (2) the inspection of new installations for adherence to design standards and specifications.

Process Unit Shutdown Scheduling

Process Unit shutdowns are scheduled for 12 months in advance and are revised periodically.

Fig. 1 is an example of a process unit shutdown schedule.

Rotating Machinery — Except Electrical

The portion of the Avon program pertaining to pumps, turbines, gas engines, blowers, fans, and compressors has been developed and is administered by the machinery inspector who is an engineer.

Fig. 2 is a sample maintenance record card for a centrifugal pump.

Fig. 3 is a sample of additional data kept on the back of the maintenance record card for this particular centrifugal pump and shows the "indicated life and frequency of parts with normal wear" plus yearly maintenance costs on the pump.

Electrical Equipment

Motor servicing involving greasing is handled through a "tickler" file system maintained in each of the three zone offices and based on an annual schedule which lists by weeks the motors that are to be serviced. The zone planner uses the annual motor servic-

CENTRIFUGAL PUMP DATA

MFGR.	XYZ
TYPE	ABC
SIZE	4"
SERIAL	12345
NO. STAGES	1
PARTS LIST DWG. NO.	ABC-1
PERFORMANCE CURVE NO.	54321
A.F.E. NO. 4500	S.O. NO. 45006
REQ. NO. 999-45	COST $3586
DATE INSTALLED	1944
CASE INITIAL THICK.	RETIRING THICK.

OPERATING CONDITIONS

SERVICE	Furnace Charge
G.P.M. AT PUMPING TEMP.	900
FLUID	Residuum
SPECIFIC GRAVITY AT PUMPING TEMP.	.8-.9
PUMPING TEMPERATURE °F	500
VISCOSITY S.S.U. AT PUMPING TEMP.	230
DISCHARGE PRESSURE, P.S.I.G.	430
SUCTION PRESSURE, P.S.I.G.	260
DIFFERENTIAL HEAD, FT.	488'

PERFORMANCE

R.P.M.	3550
PUMP ROTATION FROM DRIVE END	CCW
PUMP EFFICIENCY %	57 @ Rating
BRAKE HORSEPOWER	100 @ Rating
MAX. HP. OF PERFORMANCE CURVE	220
IMPELLER EYE AREA	57.5 sq. in.
IMPELLER EYE VELOCITY, FT./SEC.	
N.P.S.H. AVAILABLE	Req. 12'
IMPELLER DIAMETER (a)	11-15/16 3/4 Port.
MAX. IMPELLER DIAMETER (...)	12-3/8"
MIN. IMPELLER DIAMETER (c)	9-1/2
CASE MAX. SAFE WORKING PRESSURE	600
CASE MAX. SAFE WORKING TEMP.	500

MATERIALS

CASE (SHELL)	Carb. Steel
HEAD	Carb. Steel
SHAFT	SAE 6140
IMPELLER	11-13 chrome
IMPELLER WEAR RGS.	11-13 chrome
CASE WEAR RGS.	11-13 chrome
CASE WEAR RG. SCREWS	18-8
	Wear Ring Clear. .016

SHAFT SLEEVES	1020 w/Stellite
SPACER SLEEVES	None
SPACER BUSHINGS	None
THROAT BUSHINGS	11-13 chrome
LANTERN RING	11-13 chrome
BALANCE DRUM	None
BALANCE BUSHING	None
GASKETS	Aluminum
BEARINGS	☐ SLEEVE ☒ BALL
THRUST	5408
RADIAL	5408
PACKING	☐ MECHANICAL ☒ RING
	SIZE 1/2 sq. 2-13/16x3-13/16x5
	STYLE Alum Fo11 D100/100 AL
	MFGR Duraметallic/John Crane
	SERIAL NO.
COUPLING	#2 Fast

DRIVER

☒ MOTOR 1200 ☐ TURBINE ☐ ENGINE

DRIVER MFGR	G.E.
SERIAL NO.	6045828
H.P.	250

PART	DATE 6-45	12-45	6-46	12-47	8-48	12-52	7-53	10-19-53	10-24-53	12-14-53	1-26-54	5-1-54	6-29-54	9-1-54	9-15-54	12-28-54	REMARKS
SHAFT	N	Str	N			N	N	N	Str	N				Ok			*See Repair Report HBD - 11-54
IMPELLER	N		N					N						Ok			
IMP. WR. RG. INBOARD	N		N		N			N						Worn			1- Cut Brgs Open Tracks ok
IMP. WR. RG. OUTBOARD	N		N		N			N						Worn			
CASE WR. RG. INBOARD	N		N		M			N						Worn			Heavy Radial Loading
CASE WR. RG. OUTBOARD	N		N		M			N						Worn			
SLEEVE INBOARD	N		N			N		N						Worn			Noted - Inc. Radial Clear
SLEEVE OUTBOARD	N		N			N		N		N				Worn			in Grg. Hsg.
THRUST END BLY. BRG.	-	-	-	-	-	-	-	-	-	-	-	-	-	Worn	-	-	
THRUST BRG.	N	N	N	N	N	N	N	N	N	N	N	I	N				2 - Assy and Th.
RADIAL BRG.		N	N	N	N		N	N	N	N	N	I	N				Brg Worn Out
OUTER HEAD GASKET		N			N	N	N						N				Inst. Rebuilt
INNER HEAD GASKET		N			N	N	N						N				Assy.
PACKING HSG. GASKET		N			N												
COUPLING		Oil			Oil	Oil	Oil	Oil	Oil	N	N	Oil	Oil	Oil	Worn		
ASSEMBLY		N			N					N		Bal		N	Oil		
SHELL										M							
HEAD										M							

PUMP SERVICE RECORD

DATE	LOCATION	SERVICE	CONT. INT.	SUCT. PRESS.	DISC. PRESS.	OPER. TEMP.	SP. GRAV.	VIS. AT OP. TEMP.	REMARKS

A.D. # 3495 | LOCATION #1 F.P.U. | SERVICE Fresh Feed Furnace Charge | 1 2 3 4 5 6 7 8 9 10 11 12

TYPIST PLEASE NOTE—THIS SCALE CORRESPONDS TO TYPEWRITER (PICA) SCALE—SET PAPER GUIDES SO THAT CARD SCALE WILL REGISTER WITH BACKING SCALE WHEN CARD IS TURNED INTO WRITING POSITION. START INDEX THREE (3) POINTS FROM LEFT EDGE OF CARD. USE OTHER POINTS OF SCALE FOR OTHER DIVISIONS OF VISIBLE TITLE. SEE TABULATING TO ENSURE PERFECT ALIGNMENT OF EACH DIVISION OF INFORMATION. FOLD BACK ON PERFORATIONS AFTER TYPING. USE WITH TYPEWRITER RIBBON.

TIDEWATER ASSOCIATED OIL CO., ASSOCIATED, CALIF.

FIG. 2. Sample maintenance card for a centrifugal pump.

INDICATED LIFE AND FREQUENCY OF PARTS WITH NORMAL WEAR

PART	LIFE (months)	MIN. SERVICE (month)	MAX. SERVICE (month)	WEAR RATE	COST PER YEAR
CASE	00			None Measurable	108.
IMPELLER	36	24	60	" "	108.
SLEEVES	36	36	60	" "	425.
IMP. WR. RG.	32	32	64		130.
CASE WR. RG.	32	32	64	.002/mo	54.
SPACE BUSHING	None	-	-	.002/mo	5275.
SPACE SLEEVE	None	-	-	-	2434.
GLANDS	00			-	156.
THR. BRG.		12	18	None Noted	
RADIAL BRG.		12	18		
BRG. JOURNAL	Ball Brg Fit	-	-	-	
SHAFT	36	36	60		
COUPLING		24	108		

FIG. 3. Sample data, additionally placed on back of card in Fig. 2.

REFINING IN BRIEF

Tidewater Oil Company,
Western Division

Automotive Department
May 1, 1956

VEHICLE SERVICE SCHEDULE -- MILEAGE BASIS

I. GROUPS - A, B, C, and D: Contract garage or Tidewater shop men will make required adjustments and/or replacement of minor parts. When an A, B, C, or D SERVICE is performed on a vehicle, record the particular group service identity in the respective Vehicle Maintenance and Inspection Record, Form 3825.

II. OTHER WORK than the inspection, adjustment, and lubrication of items as listed in the SERVICE SCHEDULE will be classified as repairs or replacements and NOT service work. Maintenance repairs and/or major replacements of component units of a vehicle are to be identified on time cards separately from the GROUP SERVICE work.

III. Mileage Period - Group Services - **TRUCKS include Classes 3, 5, 6, 7, 8, and 9 Commercial Vehicles. ***AUTOMOBILES include Class 1, Light Duty Trucks.

IV. For Lubrication Products refer to LUBRICATION GUIDE FOR AUTOMOTIVE EQUIPMENT.

V. NO ROAD TEST is required at the "A" SERVICE unless unsatisfactory conditions are indicated orally or recorded in the "Condition of Vehicle" report on Forms 3680, 4671, or 4671-A (Daily Report of Automotive Vehicle, Transportation Request and Pool Car Record, or Weekly Transportation Request and Pool Car Record, respectively).

VI. When shop adjustments are made to brake, carburetor, or ignition systems or steering assembly, a short ROAD TEST is required to determine that such units are operating satisfactorily before vehicle is released to service.

VII. Before performing GROUP "A" Service, a brief visual check of the underside of chassis is to be made for broken supporting brackets, defective muffler shell and tail pipe, loose or damaged steering linkage, and broken or loose parts in the front and rear spring suspensions. Should replacement parts be required, they should be obtained promptly, so that vehicle may be returned to service with minimum delay.

**TRUCKS -	GROUP A	***AUTOMOBILES -
1,000 MILES OR MINIMUM PERIOD - 60 DAYS		1,500 MILES, OR MINIMUM PERIOD - 60 DAYS

1. ENGINE COOLING SYSTEM: Check the following items:
   Fan belt - tension and condition.
   Water pump - for packing gland leakage.
   Radiator and connecting hoses for leakage and condition.
   Clean bug screen.
2. CARBURETOR AIR CLEANER: Clean - replace oil when dirty.
3. HEAT RISER CONTROL VALVE: Check for working condition (lubricate shaft with iodine solution).
4. ENGINE GOVERNOR: Check operating action and seal.
5. BATTERY: Check fluid level and terminal connections for cleanliness and tightness.
6. LIGHTS, HORN, WINDSHIELD WIPER, AND PANEL INSTRUMENTS: Check for satisfactory operation.
7. BRAKES: Check foot and parking brake levers for excessive travel - adjust if necessary. Check fluid level in hydraulic master cylinder for proper level. Drain air reservoir tanks when vehicle is so equipped.
8. TIRES: Examine for irregular wear. Remove nails, glass, etc. Inflate - replace missing valve caps.
9. TRANSMISSION AND DIFFERENTIAL: Check lubricant level - replenish if necessary - check air vent openings.
10. LUBRICATE CHASSIS (including distributor, generator, starting motor, throttle controls, door hinges and latches - brake and clutch linage).
    NOTE: When extreme wet weather conditions exist, chassis lubrication only (low mileage vehicles) should be performed at a minimum period of 30 days. Under such conditions, wheel steering knuckle pins must be adequately lubricated.
11. ENGINE OIL CHANGE:
    a. Vehicles traveling under 700 miles monthly (low mileage) - EVERY "A" SERVICE.
    b. Vehicles traveling over 700 miles monthly (high mileage) - EVERY SECOND "A" SERVICE.
    CAUTION: When engine is used for extensive operation of vehicle cargo pump or winch, oil is to be changed at the "A" Service, irrespective of monthly mileage.
12. ENGINE OIL FILTER:
    a. Vehicles traveling under 700 miles monthly - CHANGE ELEMENT every THIRD oil change.
    b. Vehicles traveling over 700 miles monthly - CHANGE ELEMENT every SECOND oil change.

**TRUCKS -	GROUP B	***AUTOMOBILES -
3,000 MILES		6,000 MILES

1. RADIATOR: Replenish rust inhibitor - soluble oil type - use "Bar's Leaks" - 6 oz. container (cooling systems - 5 to 7 gals.) obtainable through T.B.A. supply. Check water temperature gauge for working condition. If doubtful, check water thermostat for operation - 160° F. thermostat recommended. When anti-freeze solution is used in "cooling system," soluble oil is not required.
2. ENGINE CRANKCASE VENTILATOR: Clean and re-oil breather filter.
3. ENGINE FUEL SYSTEM: Clean fuel pump sediment bowl - tighten fuel line connections.
4. AIR COMPRESSOR: Clean and re-oil filter element.
5. VACUUM BRAKE BOOSTER: Clean and re-oil air filter element.
6. RIMS AND WHEELS: Replace broken studs and tighten nuts.
*7. DISTRIBUTOR: Inspect ignition points for condition - adjust; check governor advance - clean rotor and housing.
*8. SPARK PLUGS: Clean - adjust gap - replace gaskets if flat. Check heat range for satisfactory operation.
    *NOTE: When engine tune-up is performed at "C" Service, items 7 and 8 should be done jointly with engine tune-up operations.

**TRUCKS -	GROUP C	***AUTOMOBILES -
10,000 MILES		12,000 MILES

1. AIR, HYDRAULIC, OR VACUUM BRAKE LINES: Check for chafing, unsupported lines - tighten fittings.
2. WHEEL STEERING ASSEMBLY: Check linkage, spindles, and steering worm assembly for tightness. Adjust if necessary.
3. CLUTCH PEDAL: Adjust travel to factory specification.
4. DRIVE LINE ASSEMBLY: Check flanges and sliding joints for tightness - universal joints for leakage or worn condition.
5. WHEEL BEARINGS: Jack up wheels - check for looseness and adjust if necessary.
6. ENGINE CYLINDER HEAD: Check for gasket leaks - tighten head bolts, use torque wrench.
7. ENGINE TUNE-UP: Use test instruments - check battery gravity and voltage - manifold vacuum* - compression pressures - voltage and current regulator - generator charging rate - engine timing - fuel pump (pressure and vacuum) - carburetor for cleanliness, float and air adjustments - exhaust gas analysis. Record findings and results (before and after adjustments) of engine tune-up information on Form 4489. For further clarification of tune-up procedure, refer to Automotive Department "Supplement to Manual Instructions No. 3." Record engine operating temperature and oil pressure (hot engine) in Remarks section, Form 4489.
   *NOTE: Should tune-up findings indicate need for adjustment or conditioning of engine valves, such work should be performed before checking engine timing and exhaust gas analysis.
8. BRAKE LINING: See Group D - Item 8 - *Note

**TRUCKS -	GROUP D	***AUTOMOBILES -
15,000 MILES		18,000 MILES

1. ENGINE WATER COOLING SYSTEM: Drain and flush, except vehicles containing anti-freeze. CAUTION: Cooling systems containing soluble oil rust inhibitor should be drained and flushed before anti-freeze solution is used. Check soft plugs in cylinder block for leakage.
2. DISTRIBUTOR: Remove from engine - clean housing of surplus oil or grease - check distributor shaft bushing and driven gear for excessive wear - governor advance mechanism for proper operation.
3. STARTING MOTOR: Clean commutator of oil or grease.
4. ELECTRICAL SYSTEM: Check for tightness at connections - general condition - and adequate support of wiring.
5. VEHICLE SPRINGS: Front and rear, inspect for breakage or misalignment. Tighten clips and U bolts.
6. BOLTS AND NUTS: Tighten chassis, cab, body, mounting, engine manifold and mounts.
7. WHEEL BEARINGS: Clean - inspect - repack with fresh lubricant.
*8. BRAKE LINING: Clean lining and drums of surplus oil or grease. Inspect for wear. Record in Vehicle Maintenance Record condition of lining and drums for reconditioning or replacement. Check hydraulic wheel cylinders, or air diaphragms, and lines for leakage. CAUTION: If one cylinder or diaphragm shows indication of leakage, replace all such units on the particular vehicle.
   *NOTE: Where extreme "braking conditions" exist, brake lining should be inspected for condition at the "C" Service. Replace loose or worn lining.
9. DIFFERENTIAL AND TRANSMISSION: Drain and flush - refill with fresh lubricant. Examine drained lubricant for metal chips.
10. SPEEDOMETER: Remove drive cable - inspect - lubricate.
11. SHOCK ABSORBERS: Check for satisfactory operation. Repair or replace if necessary.
12. VACUUM BRAKE BOOSTER - PISTON TYPE: Lubricate through pipe plug opening in cylinder shell. Use Tydol HD-30.

FIG. 4. Automotive vehicle maintenance schedule card.

ing schedule as a guide in preparing the daily work schedule for his zone.

Motor bearing oiling and the servicing of other electrical equipment are performed by electric shop personnel on the basis of established schedules.

Instruments and Controls

Preventive maintenance on instruments and controls is administered by the instrument shop. Avon refinery policy has been to concentrate responsibility for the inspection and maintenance of all instruments and controls in one craft — whether they are mechanically, electrically, or electronically operated.

Equipment records are being kept on relief and control valves. Valves are serviced, where possible, on schedules accompanied by check-off lists.

Automotive Vehicles

All automotive vehicles at the Avon Refinery are serviced on established preventive maintenance schedules based upon mileage and hours of operation. Fig. 4 is an example of such a schedule.

Planning and Scheduling

Avon refinery has a formal planning and scheduling system based on the following general principles:

1. Work is authorized through the medium of individual written job orders.
2. Each job order is planned and estimated to the nearest hour.
3. Priorities are of three classes — emergency, No. 1 priority and No. 2 priority.
4. Blanket job orders, supported by written schedules and for a definite period of time, are issued to take care of recurring inspection and minor maintenance.
5. Manpower required is balanced daily against manpower available in the various crafts.
6. A written daily work schedule is issued by a central planning office.
7. Major maintenance jobs (including process unit shutdowns) together with new construction projects are planned and scheduled.
8. Effort is made to keep emergency jobs to a minimum.

Personnel

Avon has a training program for mechanics, inspectors and operators. It is jointly administered by management and the union and has been very successful.

Assignment of engineers to the maintenance organization has been in effect for several years.

The Future

The refinery is engaged in an extensive expansion program. Provision for preventive maintenance is a part of the program and is being developed concurrently with the construction of new facilities. ★ ★ ★

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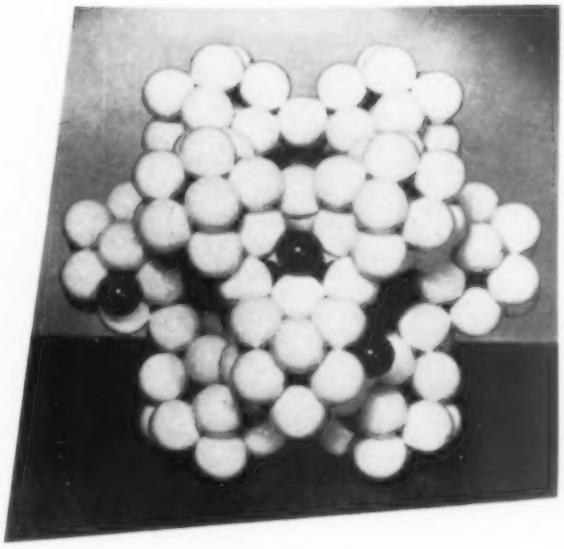
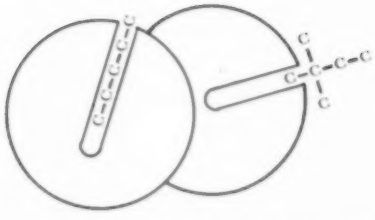
Now being widely adapted as a desiccant for refrigerants, "sieves" show good promise as a selective adsorbent for hydrocarbons. There are problems, though

MOLECULAR SIEVES

Processing Tool of the Future?





Straight chain hydrocarbons are adsorbed in the tiny pores of the sieves, but isomers can't get in.

MOLECULAR sieves — are they the processing tool of the future or just a laboratory curiosity? Several research units are spending thousands of dollars to find the answer.

Chemically, molecular sieves are synthetic zeolites, similar to many natural clays that also are composed of soda, lime, alumina, and silica. The atoms of sodium or calcium, aluminum, and oxygen in molecular sieves are arranged in a definite crystalline structure that contains a large number of small cavities, interconnected by still smaller pores. These cavities and pores are precisely uniform in size.

How they work. The cavities in the sieves try to recapture water molecules that were driven off in manufacture. When water is not present, the pores will adsorb any molecule that is small enough to get in. Linde Air Products Company, developers and manufacturers of molecular sieves, has two "sizes" available: Type 4A will adsorb molecules not greater than four Angstroms diameter (ethane), while the 5A product will adsorb molecules not greater than five Angstroms in diameter (propane, butane, hexane). Sieves will adsorb many types of straight-chain hydrocarbons and their oxygenated derivatives. But, isomers and cyclic compounds are too big to "get in the act." Furthermore, sieves are relatively insensitive to temperature effects; they will adsorb molecules in the gas as well as liquid phase.

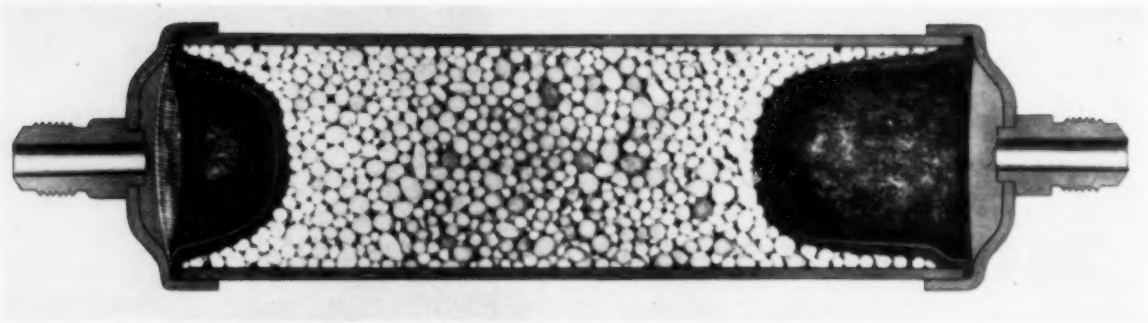
Applications being studied for and in the petroleum industry include:

1. Removal of normal paraffins from light naphtha and reformates.
2. Removal of sulfur compounds from hydrogen and . . . possibly . . . gasoline.
3. Drying and processing of lubricating oil.

ADSORPTION CHARACTERISTICS OF MOLECULAR SIEVES.

. . . . . Adsorbed on		
4A and 5A	**5A, not 4A**	**Can't get "in"**
Water	Propane and higher n-paraffins up to at least C_{14}	Iso-paraffins
Carbon Dioxide	Butene and higher olefins	Iso-alcohols
Carbon Monoxide*	n-Butanol and higher n-alcohols	Aromatics
Hydrogen sulfide	Cyclopropane	Naphthenes
Sulfur dioxide	"Freon" 12	Cyclic paraffins above C_8
Ammonia		Carbon tetrachloride
Nitrogen*, Oxygen*		Boron trifluoride
Methane*, Menthanol		"Freon" 114
Ethane, Ethanol		"Freon" 11
Ethylene, Acetylene		All molecules larger than 5.0 Angstroms
Propylene, -n-Propanol		
Ethylene Oxide		

*Appreciable quantities are adsorbed only below —20 F.



Refrigerant drying cell packed with molecular sieves. — Courtesy The McIntire Company.

4. Recovery of olefins from refinery gas systems.
5. Drying and sweetening of natural gas.

Glancing at the table of characteristics, many applications in petrochemicals manufacture are evident. Refiners are giving special attention to the ability of molecular sieves to remove normal paraffins from light naphtha and reformates. Paraffins are not only the lowest octane component in gasoline cuts, but also give the poorest catalytic reforming yields. Looking at the "other end" of catalytic reforming, a unit could be operated to produce 90 Research octane-clear blending component. Overall yield would be greatly improved, and the size of gas processing equipment reduced. Initial investment in catalyst would be lowered, and its activity extended.

Also, normal paraffins would find outlets in solvents, jet fuels, feedstock to petrochemical units, and as feedstock to isomerization units.

There are knotty problems to be solved before molecular sieves can be used in commercial refining operations, though. Not least among these is relatively high cost of sieves. . . . but Linde can probably solve this if and when mass production gets into high gear. Also, in order to have a continuous process, at least two cases are required, one on adsorption, the other on the regeneration cycle. Some feel that, in order to be commercially feasible, a completely continuous process must be developed.

Regeneration or recovery of adsorbate is causing some problems. High temperatures and vacuum will do the trick, but the equipment needed for a commercial unit would be quite costly. Still another approach is to use purge gas at temperatures ranging from 300 to 600F.

Already in commercial production, molecular sieves indicate still another revolution in refining . . . if and when the cost headaches are solved. Will they have the same impact as catalytic cracking and catalytic reforming, or will they be tucked back onto the laboratory shelves? With the amount of research attention that they are getting, the answer should be known fairly soon. ★ ★ ★

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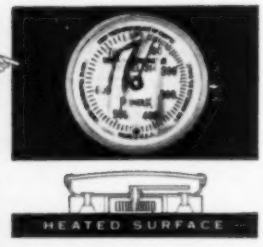

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Analytical Methods

Isooctane-TEL as "Above 100" Octane Number Reference Fuel

Coordinating Research Committee after five years study recommends reference fuel for ratings

FIVE years of study by a special group of the Motor Fuels Division of the Coordinating Fuel and Equipment Research Committee of CRC has resulted in the following recommendations for expressing antiknock ratings of motor fuels:

1. The present octane-number is to be used to define fuel antiknock quality at and below 100.

2. The units of measurement above 100 are also to be called octane numbers.

3. The extension of the octane-number scale above 100 is to be defined in terms of isooctane and tetraethyl lead. Fig. 1 shows this relationship.

These recommendations are contained in a report (CRC-296), "A Method for Expressing Antiknock Ratings of Motor Fuels above 100," recently issued by CRC.

For the table of octane numbers of blends of isooctane and TEL see page C-52, THE REFINING ENGINEER for November, 1956.—Ed.

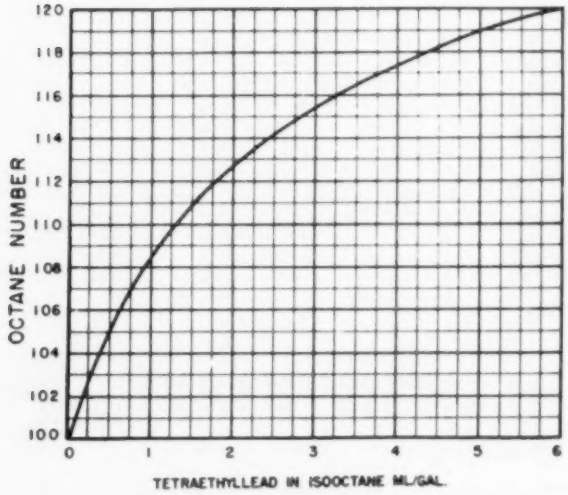

FIG. 1. Relation between isooctane plus TEL and octane numbers above 100.

Why the Scale Is Needed

Ever since the commercial introduction of 100-octane gasoline as an aviation fuel, the necessity for establishing a reasonable numerical system for expressing the antiknock value of fuels above 100 has been evident. During the war, with the assistance of the CFR Committee, a method known as the Army/Navy performance number was generally adopted by those concerned with the development and use of aviation gasoline.

In recent years many methods for expressing antiknock values of aviation fuels above 100 have been used and proposed for general adoption. CRC Report 241, "Method for Expressing Aviation Fuel Antiknock Ratings," dated 1949, deals at some length with a great number of these. Broadly speaking, they can be divided into two classes:

1. Those proposing the use of different reference fuels, such as:

(a) Leaded isooctane and leaded normal heptane.

(b) Leaded isooctane + 10 per cent toluene and leaded normal heptane + 10 per cent toluene.

(c) Leaded triptane (2,2,4 trimethylbutane) and leaded normal heptane.

2. Scales that are derived mathematically from isooctane-normal heptane performance curves, or isooctane + TEL performance curves, such as:

(a) AGAC F-3 scale.

(b) AN performance-number scale.

(c) Detonation index (D. B. Brooks).

(These are only examples; they are

not intended to be a complete bibliography of the various proposals.)

In 1950 interest in the extension of the octane-number scale for motor fuels became apparent. A Motor Fuels Division group was formed to "study the question of finding a suitable means of expressing fuel antiknock ratings above 100 octane number." Various possibilities were discussed in the next two years. There was no indication from industry that aggressive action was needed at that time. When it became evident that this group could not develop a scale that would find general acceptance, a compromise agreement was reached wherein two scales were recommended for further study. Both were based on the use of isooctane plus TEL as a reference fuel. One was the AN performance-number scale and the other was an extension based on the formula: Octane number = 128 — 2800/PN. The group was disbanded in 1953, since the two scales were already available and under study, and people expressed the desire to have a period of time in which to evaluate them.

Since that time, fuel antiknock quality and engine compression ratios have reached levels such that representatives of many companies, both petroleum and automotive, expressed intense interest in selecting at an early date an extension that would be satisfactory to all. In view of this interest, the Motor Fuels Division sponsored an informal symposium in Detroit on April 26, 1955, to discuss extension of the octane-number scale.

Qualifications of a Satisfactory Scale

Discussion at this symposium indicated that (1) there was now an intense interest in the subject, (2) there was an immediate need for an extended scale, and (3) some one scale should be made available to industry. From all the information presented and discussed, there evolved a majority opinion that any proposed antiknock scale should satisfy the following premises:

1. The present octane-number scale below 100 should be retained.

2. The octane-number scale below 100 should continue to be defined in terms of normal heptane and isooctane. The scale above 100 should be defined in terms of isooctane and tetraethyl lead.

3. The octane-number scale extension should be continuous with the octane-number scale in the region of 100.

4. The octane-number scale extension should have a definite relation to engine performance in the region above 100.

There has been practically unanimous agreement that the units of the scale above 100 should be called octane numbers.

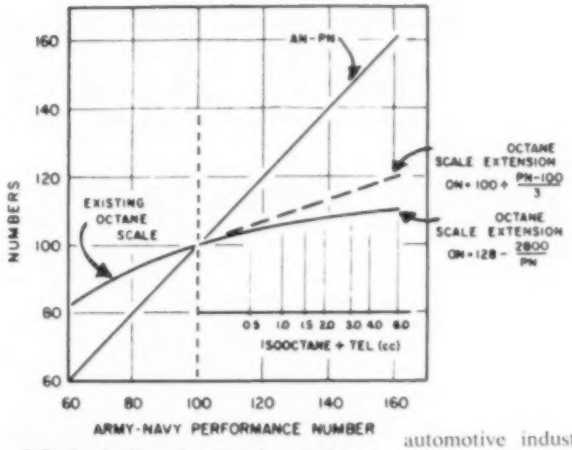

FIG. 2. Antiknock extension scales.

Although many different scales were considered by this group, interest centered on the following methods:

1. 1-3-5 trimethyl benzene (mesitylene) and normal heptane.
2. Performance-number scale.
3. $ON = 128 - \frac{2800}{PN}$.
4. $ON = 100 + \frac{PN - 100}{3}$.

Any scale based on two fuels for the entire antiknock range fails to satisfy premises No. 1 and 2. This method does have the advantage, however, of eliminating any discontinuity at 100 and provides an easily defined scale for the entire antiknock range that is covered. A question has been raised as to the suitability of the second part of premise No. 2. This is based on evidence that the reproducibility of the octane-number determinations above 100 ON is not as satisfactory as it is immediately below 100 ON and that the use of isooctane plus lead as reference fuels is a contributory factor. It is, therefore, recommended that work be pushed until sufficient information is available to assess the potentialities of reference fuel systems.

From an examination of the performance-number scale, as shown in Fig. 2, it is evident that it fails to meet premise No. 1. If the PN scale were adopted only for numbers above 100, as has been done in the aviation industry, such a scale would fail to meet premise No. 3. The advantage of this scale, however, is that it is closely related to engine performance. The PN scale had its origin in a series of engine tests in which the knock-limited output of a number of aircraft engines was related to the quantity of TEL in isooctane. In this test program the intake manifold pressure was varied to change the level of engine performance. While the practice of supercharging is not generally employed in the automotive industry, numerous tests on automotive engines have demonstrated that a generally linear relationship exists between the performance of these engines and the PN scale above 100. Data supporting this relationship are shown in the report.

The antiknock scale extension based on ON = 128 — 2800/PN is continuous at the 100-octane point when plotted against the PN scale. The curvature of this scale makes each successive octane number above 100 represent a greater and greater amount of antiknock value. This characteristic results in an antiknock rating of 110.6 for isooctane plus 6 ml TEL, which was considered by many parties as too low a number for the amount of antiknock value it represents.

The only approximation in the ON = 100 + (PN — 100)/3 proposal as far as the four premises are concerned is that the scale is not strictly continuous at 100 octane number. This extension was constructed on a plot of octane numbers versus performance numbers by extending a straight line connecting the 95 and 100 octane points. It was found that this extension had a slope that was almost exactly one-third that of the PN scale. For convenience, the extension was based on the one-third slope and the simple expression ON = 100 + (PN — 100)/3 was derived.

CRC-296 contains 32 pp., including 15 graphs and a table of TEL and octane numbers as derived from the equation, covering octane numbers from 100 to 120.44. It is available from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: $1.50 to members, $3.00 to nonmembers. ★ ★ ★

Because of the universal interest in this important field, this article is being presented by permission of the Society of Automotive Engineers. It appears in the SAE *Journal* for November, 1956, under the title "CRC Extends ON Scale Above 100." — *Editor.*

REFINING AND PETROCHEMICAL

PERSONALS

A. J. Wood has been named superintendent-operations at Shell Oil Company's Houston, Texas, refinery. Wood was chief technologist at Shell's Wood River, Illinois, refinery.

Max M. Fisher has been elected chairman of the board of Aurora Gasoline Company following the resignation of **Henry E. Wenger.** Fisher formally was executive vice president and secretary of the company.

H. E. Hughes, superintendent of Shell Chemical Corporation's, Houston, Texas, plant, has been named the new manager of the company's Denver plant. **J. W. Hyde,** assistant superintendent, operations, at Houston, has assumed the superintendent's position. Also announced, **F. G. Watson** has become assistant manager of manufacturing development and is succeeded in his post by **C. H. Plomteaux,** assistant superintendent at Shell Chemical's Norco plant.

Houdry Process Corporation has announced the promotions of **George F. Hornaday** to associate manager of research and development and **D. Eugene Norris** to assistant process sales manager, succeeding Hornaday.

Hinton J. Dillard, Denver, Colorado, has been promoted to resident chemist of Continental Oil Company's Denver refinery. Formerly assistant chemist at the Denver refinery, he will be succeeded by **Robert Schlessman,** Wichita Falls, Texas.

M. F. Wirges has been appointed manager of the natural gasoline division of Arkansas Fuel Oil Corporation. Wirges suggeeds **Fred H. Ramseur, Jr.,** who was recently promoted and transferred to the Cities Service Company main offices in New York as coordinator of light ends and natural gasoline plants.

M. F. Wirges

L. T. Wilson

L. T. Wilson, former manager of Shell's Montreal East Refinery, has been appointed director of refining and supplies with Compania "Shell" de Venezuela. He will be headquartered in Caracas. **J. L. Miller,** appointed to succeed Wilson, formerly was superintendent-operations, Houston, Texas, refinery.

Dr. Charles H. Riesz, an authority in the field of catalysis, has been promoted to senior scientist at Armour Research Foundation of Illinois Institute of Technology, Chicago, Illinois. Riesz came to the Foundation in 1952 from the Institute of Gas Technology.

Lawrence P. Horwitz, Forest Hills, New York, has been awarded a Shell Foundation Fellowship in Physics. He is in his fifth year of graduate work at the Harvard Graduate School of Arts and Sciences. **Paul S. Hubbard,** St. Petersburg, Florida, has been awarded a Texas Company Fellowship in Physics. He is in his fourth year of graduate work at the Harvard Graduate School of Arts and Sciences.

Dr. Sherman S. Shaffer, staff associate in the technical and research divisions of the Humble Oil and Refining Company, Baytown, Texas, has been elected chairman of the American Chemical Society's division of petroleum chemistry for 1957. He succeeds **Dr. Alex G. Oblad** manager of research and development of the Houdry Process Corporation, Marcus Hook, Pennsylvania.

Harold M. Smith, assistant supervising engineer of the U. S. Bureau of Mines, Bartlesville, Oklahoma, has been named chairman-elect and **Wheeler G. Lovell,** director of automotive products development of The Ethyl Corporation, Detroit, Michigan, re-elected secretary-treasurer.

Harold G. Teverbaugh has been appointed vice president of Texas Natural Gasoline Corporation. In his new position, Teverbaugh will devote the major part of his time to administrative and supervisory work for the engineering and gas department of Texas Natural.

NEW... HIGH VACUUM PUMP from Refinery Supply the VIBRATION'S gone and so is the noise with the HYVAC-7

No. 91505, 60 cy. 115/230 volts
$254.50

No. 91500, same as No. 91505, but without motor or base
$199.50

Here's a vacuum pump that is so carefully designed . . . so expertly machined . . . so perfectly balanced . . . that vibration has been reduced to an absolute minimum. Result . . . smooth, quiet operation. You can hardly hear it as it runs. In fact, its noise level is lower than that of any similar pump.

The new Cenco Hyvac-7 has more pumping capacity per cubic foot of space occupied than any other vacuum pump now available. It produces a free air displacement of 70 liters per minute and a guaranteed ultimate vacuum of 0.1 micron. This pumping speed in the low micron range is exceptionally high. The ratio of pumping speed at 1 micron to that at atmospheric pressure is 49%. And it pumps from atmospheric to ultimate pressure in less than five minutes.

This finest, most efficient of all vacuum pumps is now ready for shipment.

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The most complete line of scientific instruments and laboratory supplies in the world

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SANTA CLARA LOS ANGELES TORONTO MONTREAL VANCOUVER OTTAWA

NEW Refining Equipment

• machinery • supplies • services

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Smallest TV Camera Aids Research and Production. A streamlined, miniature TV camera small enough to be held in the palm of the hand has been made available to the industry.

Camera, with a variety of lense and mirror attachments, measures only 5¼ in. long, and 2 in. in diameter. Tiny wheels enable the camera to examine the inside of small tubes or boilers. Built-in light source illuminates inspection area. Camera is moved back and forth simply by drawing or pushing the thin, perlon cable which houses remote control and power wires.

Uses for the camera are countless — gages and instruments can be remotely monitored; close-ups of reactions and experiments can be viewed from a safe distance; areas not accessible to the human eye can be examined, and some inspections can be made in oil or water wells.

A new type of Vidicon with extremely small dimensions made the development

of this tiny TV camera possible. Subject to physical laws, these small Vidicons, of course, cannot have the same efficiency as the normal ones. Therefore, application of the miniature TV camera should be restricted on such cases, where the normal TV camera cannot be used because of its size, e.g. as to examine the interior of tubes.

Camera is manufactured by Grundig of West Germany and is adaptable to industrial TV monitors presently used at this time. *Majestic International Sales Corporation.*

Please circle (41) on reply card.

Double-Beam Infrared Meter. A double-beam infrared spectrophotometer has been announced by the instrument division of Perkin-Elmer. Called the Infracord Spectrophotometer, it has been designed primarily for use by the organic chemist at his bench. Low cost and simplicity of operation are intended to appeal to small companies and laboratories who have not considered it feasible to purchase more expensive infrared instruments.

Instrument has considerable versatility. It may be used for fast purity checks of raw materials, for recording the progress of an organic synthesis, for molecular structure elucidation, and for precise quantitative analysis. In less time than is necessary to determine a single physical property such as melting point, the organic chemist can obtain a permanent record giving a complete qualitative and quantitative picture of the compound.

New instrument is a compact, self-contained unit which will fit easily atop a normal-sized desk. It measures 27½ in. long by 17 in. wide by 8½ in. high.

The Infracord Spectrophotometer scans a spectral range from 2.5 microns to 15.0 microns. Resolution is 0.05 microns at 10

microns. Wave-length accuracy is 0.03 microns throughout the rocksalt region, and wave-length reproducibility is better than 0.01 microns.

Many of the standard Perkin-Elmer infrared accessories can be used with the Infracord Spectrophotometer. Special sealed cells, microcells, gas cells, and KBr disc holders will be available. Recording paper in either transmission or absorbance units. *Perkin-Elmer Corporation.*

Please circle (42) on reply card.

All-Electric Valve Actuator. All-electric actuator is a development of Conoflow.

Series "D" Actuator is an all-electric proportional positioning device for use in conjunction with modern electronic control systems. It requires no intermediate pneumatic or hydraulic-operating fluids. Unit combines an all-electric system with the mechanical simplicity and ruggedness of commercial pneumatic actuators. *Conoflow Corporation.*

Please circle (43) on reply card.

New Policy — Faster Service

Commensurate with our policy of better aids for the petroleum industry, we are initiating with this issue a new faster reader inquiry system to aid in supplying you with information concerning new products, new literature, and products advertised in this issue.

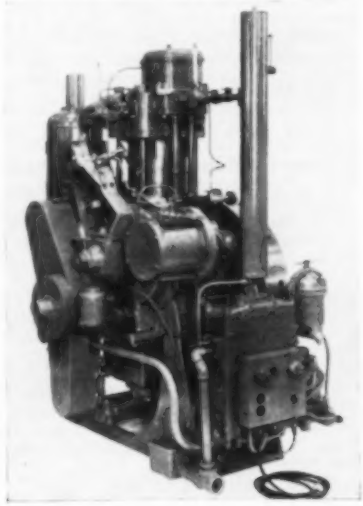
Our goal with the new system is to get your request in the manufacturers' hands as soon as possible. Our sights are set high — your request to the right man in 10 days.

Along with this, look for more information — in New Equipment — better coverage of the latest tools in refining, the newest in petrochemicals, and outstanding new services that are being made available each month for your improved operation.

— James A. LeVelle
Engineering Editor

Lubricant Test Engines. The smallest engine produced by Caterpillar Tractor is a single-cylinder diesel test engine, the only one of its design and usage in existence. Unit is designed for companies in the oil industry who use it in testing diesel engine lubricants.

Test engine was originally introduced in 1933. Due to the increased technology of lubricants, the engines are now avail-



able in three arrangements, each serving a different purpose in the qualifications of advanced lubricating oils.

Basic engine arrangement is a naturally aspirated 5¾-in. bore by 8-in. stroke, single-cylinder diesel test engine. Included in the basic arrangement are the necessary engine accessories such as heat exchangers for cooling the lubricating oil and cooling water, oil and water temperature controls, temperature measuring equipment, etc. The lubricating oil tests are normally run at approximately 22 bhp at 1000 rpm for 480 hr using this engine.

One of the change-over groups is a supercharger arrangement, which permits the 5¾-in. bore by 8-in. stroke engine to operate on lubrication oil tests at approximately 42 bhp at 1200 rpm. A high-speed test changeover group, allows a basic engine to be converted to a 5⅛-in. bore by 6½-in. stroke engine to operate at approximately 42 bhp at 1800 rpm. This test is normally run for 480 hr, and is used as the primary test in evaluating Superior Lubricants (Series 3).

Results of the test engine alone are not enough, Caterpillar feels. Findings derived from the engine must be correlated with lubricant performance in diesel engines in the field, if the test engine is to be used as a valid tool in the development of lubricating oils. Oils developed in this manner have been applied satisfactorily to diesel engines operating in all conceivable services. *Caterpillar Tractor Co.*

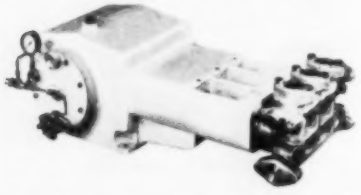
Please circle (44) on reply card.

Improved Dye Drumhead. The messiness of lifting a drumhead from a barrel of dye and dyeing gasoline from an open barrel has been removed by a new drumhead designed by Du Pont's petroleum chemicals division.

Drumhead used with Du Pont's new dry-dye eductor probe, has a 2-in. opening sealed with a polyethylene disc. The disc, slightly larger than the diameter of the probe, may be cut out with a penknife. It is threaded so that by inserting an ordinary pipe plug the barrel may again be sealed after each gasoline dyeing operation. *E. I. du Pont de Nemours & Company (Inc.).*

Please circle (45) on reply card.

Pump Fits Service Conditions. New pump is employed where corrosive slurries of viscosities as high as 40,000 centipoises are handled at medium pressures. One of its chief advantages is that the standard design may be varied to individual service conditions. Materials of construction and the drive may be specified by the customer; plungers may be equipped with packing, cups, or "O" rings; a ceramic or special alloys may be used instead of the standard Stellite valve trim, and higher pressures can be accommodated at reduced displacements. The three single-acting cylinders are available with bores of 1½ in., 2 in., 2⅜ in., or 2¾ in. The stroke is 2¾ in. Maximum capacities range from 10 to 30 gpm and maximum pressures from 450 to 1500 psig. *The Girdler Company.*



Please circle (46) on reply card.

Catalyst for Petroleum Refining. Development of another new petroleum refining catalyst for the removal of sulfur from hydrocarbons is announced by American Cyanamid. Product, a cobalt-molybdena catalyst called Aero HDS, reduces the sulfur content of petroleum fractions by conversion to hydrogen sulfide. Catalyst has high-volume activity and excellent mechanical properties.

Actual plant experience with Aero HDS shows that at 80 percent removal, 40 percent more naphtha can be treated over a given weight of catalyst.

Designed for service in both new and existing facilities, the product also lends itself to regeneration during use. Preliminary tests on a laboratory scale, using air under closely controlled temperature conditions, indicate that catalyst activity is not adversely affected by regeneration, while mechanical properties are only slightly influenced. *American Cyanamid Company.*

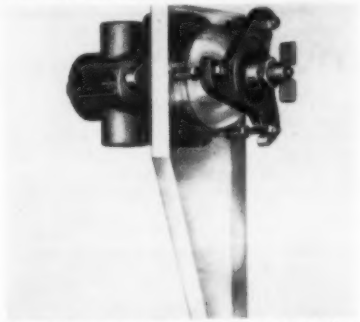
Please circle (47) on reply card.

MEN OF FORESIGHT READ NEW EQUIPMENT

MEN OF PROGRESS READ ADVERTISEMENTS

MEN OF ACTION USE READER SERVICE CARDS

Illuminator for Liquid-Level Gages. New Illuminator EPL-56 by Jerguson Gage & Valve gives up to three times the illumination. There are no glare spots or blinding areas so the liquid level can be seen clearly and easily under all conditions. Jerguson Illuminators are easily mounted on the back of the transparent gages. *Jerguson Gage & Valve Company.*



Please circle (48) on reply card.

Tool Combines Impact With Torque Control. Ingersoll-Rand announces a new development which makes it possible to run nuts with the great speed of an Impactool to a controlled torque. The company has developed an air-operated Torque Control Impactool which will run a nut to any desired torque, then automatically shut itself off.

Tool incorporates the torsion bar principle to torque control. The action of the mechanism can be likened to that of a pogo stick, which bounces evenly on soft ground, but suddenly rebounds higher when it strikes a hard surface. While the nut is being run to required torque, the Impactool operates at normal power and speed, but when required torque is reached and nut-running resistance is equal to the stress preset in the torsion bar, the impact mechanism rebounds instantly and trips a rubber-faced shutoff valve. *Ingersoll-Rand Company.*

Please circle (49) on reply card.

Compressors Feature Adjustable Stator Blades. Axial compressors with full stator-blade control for extended range of operating conditions with high efficiency has been announced by Allis-Chalmers. The new model axial compressors can be used with almost the same capacity variation as centrifugal units and still maintain the high efficiency and pressure rises as part load points which are characteristic of the axial compressor. Machines are particularly adapted for large-volume applications where capacity variation is necessary in oil refineries, steel mills, aircraft wind tunnel test facilities, and chemical plants. *Allis-Chalmers Manufacturing Company.*

Please circle (50) on reply card.

NEW Literature

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Industrial Liquid Meters. A revised 16-page edition of Rockwell's ER industrial meter bulletin offers additional information on factors affecting meter selection. It enables single-plant operators to be self-sufficient in ordering. It offers more complete data on meter construction — explaining, with the aid of tables and charts, which case, piston, and chamber are best suited for use with specific liquids. *Rockwell Manufacturing Company.*

Please circle (51) on reply card.

Emulsifiers-Corrosion Inhibitors. Ranging from emulsifiers to corrosion inhibitors, quaternary ammonium salts made by the chemical division of Armour show a wide variety of applications.

The chemical and physical characteristics of these cationic surface-active agents, along with their applications and formulations, are outlined in a newly published booklet called *Arquads*, the Armour trade name for quaternaries. Described as wetting, sanitizing, and emulsifying agents, the Arquads may be water soluble, oil soluble, or water dispersible, depending on their composition. *Armour and Company.*

Please circle (52) on reply card.

Sulfuric Acid Unloading. Up-to-date instruments for the safe unloading and handling of sulfuric acid are presented in easy-to-read form on a new 17 x 22-in. wall chart available from the industrial chemicals division of Olin Mathieson. It describes step by step the proper methods for pump unloading and air unloading of tank cars, with special attention to cold weather procedure. *Olin Mathieson Chemical Corporation.*

Please circle (53) on reply card.

Activated Carbon. An 8-page illustrated booklet on "Columbia" activated carbon is available from National Carbon. Opening with a discussion of adsorption as a unit operation in chemical processing, the booklet explains the properties of activated carbon that make it such an excellent adsorbent. Separate sections discuss the use of activated carbon for gas purification and separation, and as catalysts or catalyst carriers. *National Carbon Company, a division of Union Carbide and Carbon Corporation.*

Please circle (54) on reply card.

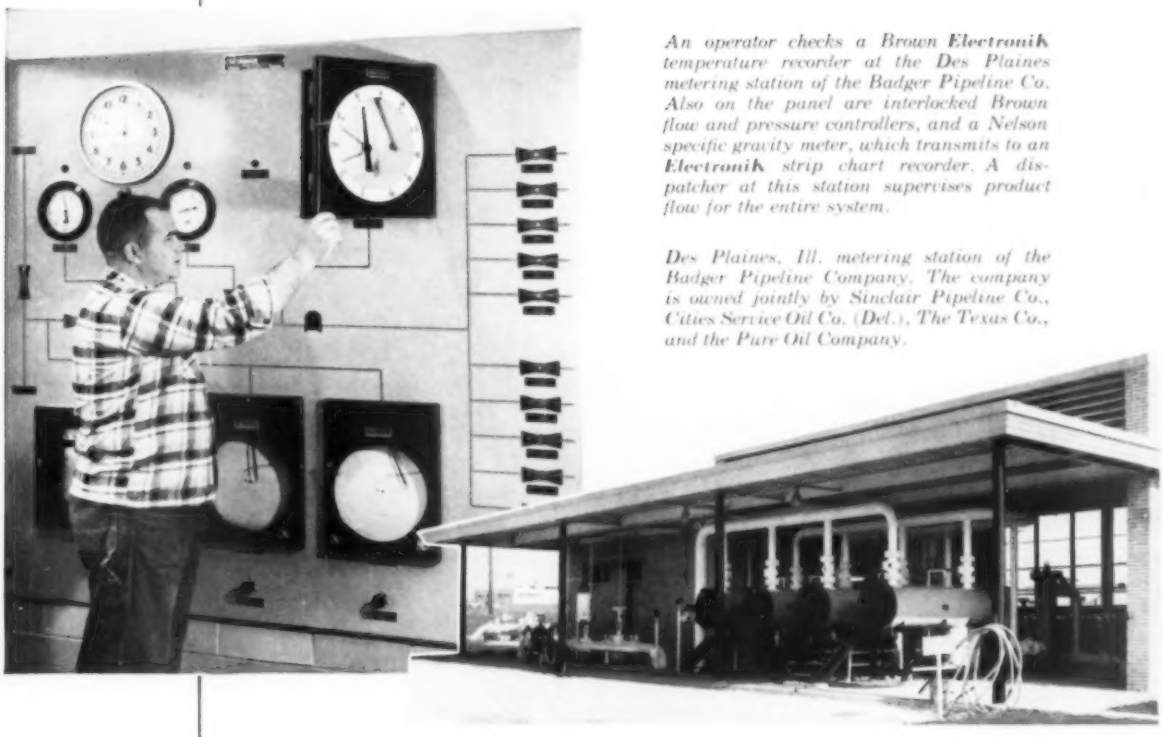
Tertiary-Alkyl Primary Amines. A new 36-page booklet describing four tertiary-alkyl primary amines is now available from Rohm & Haas. It gives physical and chemical properties, suggested applications, and chemical reactions for t-butylamine, t-octylamine, Primene 81-R and Primene JM-T. Distinctly different in both physical and chemical properties from straight primary amines, the t-alkylamines show unusual stability to oxidation and form stable derivatives such as aldimines, carbodiimides and t-alkylcyanamides. *Rohm & Haas Company.*

Please circle (55) on reply card.

Correction

REFINING ENGINEER, February, 1957. Page C-7, left hand column, line four — "hydronamic" should read "hydrodynamic."

Every station on the Badger Pipeline uses Brown instruments



An operator checks a Brown ***ElectroniK*** *temperature recorder at the Des Plaines metering station of the Badger Pipeline Co. Also on the panel are interlocked Brown flow and pressure controllers, and a Nelson specific gravity meter, which transmits to an* ***ElectroniK*** *strip chart recorder. A dispatcher at this station supervises product flow for the entire system.*

Des Plaines, Ill. metering station of the Badger Pipeline Company. The company is owned jointly by Sinclair Pipeline Co., Cities Service Oil Co. (Del.), The Texas Co., and the Pure Oil Company.

AT metering stations, at pumping stations . . . all along the Badger Pipeline . . . Brown instruments keep close watch over temperature, pressure and flow. The Badger Pipeline system serves an area surrounding metropolitan Chicago and northwest to Rockford, Ill. and Madison, Wis.

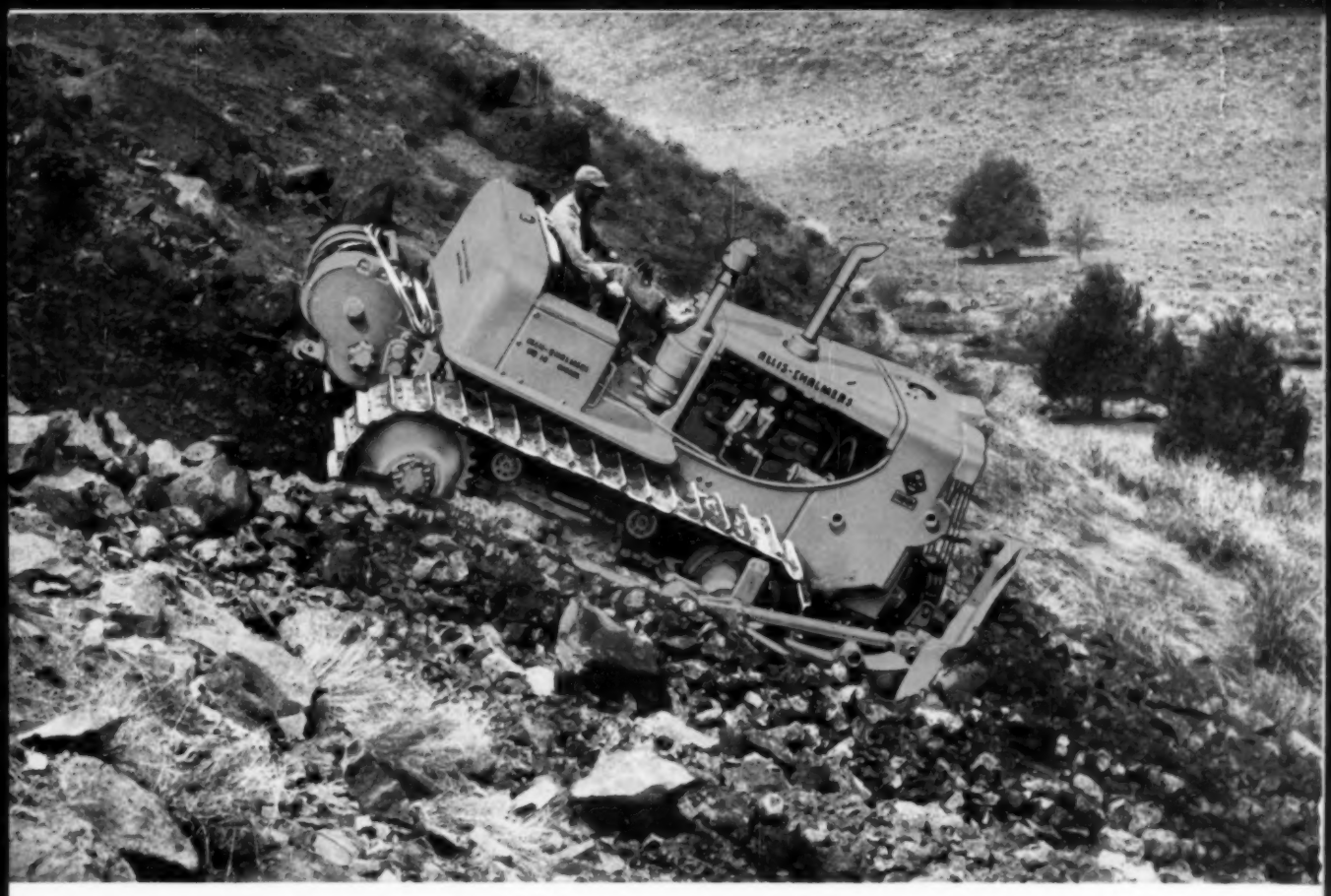
At the Des Plaines metering station shown above, *ElectroniK* recorders provide accurate temperature and specific gravity information. A Pressure Controller is interlocked with a Flow Controller to position the station control valve. Flow controller input is received from a mercuryless *Differential Converter* transmitter.

Accuracy, sensitivity, and "built-to-take-it" construction make Brown instruments ideally suited for pipeline operations everywhere.

For a discussion of your own pipeline applications, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls



ALLIS-CHALMERS ADVANCED DESIGN CRAWLERS

turn waste time into work time

You get *extra* money-making *work time* with an Allis-Chalmers crawler tractor on every pipeline job—dozing, side booming, winching, towing, pushing. Built for today's jobs, these crawlers are wheeling out more work in less time than comparable size machines.

Look at the facts

1,000-hour lubrication intervals save lube time

Allis-Chalmers tractors start the day with *go*—not greasing. You can operate six months on a 40-hour week basis with just one lubrication of truck wheels, front idlers and support rollers. Designed with Positive Seals and tapered roller bearings, these units are protected from dust, loose sand, soft ground, mud or water. You not only gain *working time*, but save labor and lubricant costs as well. And there's no costly damage from greasing neglect.

Modern shift pattern speeds digging

Here's a big timesaver on right-of-way clearing. It takes just half the time and effort to change from low forward to fast reverse with the Allis-Chalmers HD-6, HD-11, or HD-16 transmission. One simple shift of the gear lever does the job. You gain production time—up to 25 percent on actual test—on bulldozing, backfilling and other jobs calling for a short forward-backward cycle.

Unit construction cuts servicing time

No need to remove transmission or engine, radiator, grille, when servicing or removing an Allis-Chalmers master clutch. This unit can be removed without disturbing adjacent parts. This is also true of other main assemblies—final drive gear, transmission, steering clutches, engine and truck frame. You can quickly substitute an assembly and put the tractor to work while servicing the original unit. As a result, hours of *costly service and downtime are saved* because of Allis-Chalmers advanced design.

These are just three examples of Allis-Chalmers timesaving, money-making features. Your Allis-Chalmers dealer can point out many more. See him now for the full story.

ALLIS-CHALMERS, CONSTRUCTION MACHINERY DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS A-C

PIPELINE DEVELOPMENTS ★ ★ ★

Roundup of Planned and Proposed Construction

The following tables list the company, mileage, pipe size, and location of proposed pipeline projects — crude, products, and natural gas — reported to *The Pipeline Engineer*. Company addresses are given when known.

CRUDE LINES

Name of Company	Miles	Size	Location
Cape Pipe Line Company, Philadelphia, Pennsylvania	200	—	Large diameter line from Delaware Bay to Greater Philadelphia area refineries
Interprovincial Pipe Line Company Toronto 1, Ontario, Canada	151	20	Sarnia to Port Credit, Ontario
	32.6	24	Regina, Saskatchewan, to Cromer, Manitoba
Lakehead Pipe Line Company, Inc. Toronto 1, Ontario, Canada	80	26	Loop from Clearbrook, Minnesota, to Superior, Wisconsin
North-West Oil Pipelines Company	210	—	Wilhelmshaven, on the North Sea, to industrial Ruhr area of West Germany
Northwest Pipe Line Corporation Salt Lake City, Utah	350	8	Four Corners area to Salt Lake City, Utah
Offshore Gathering Company Houston, Texas	364	20	Gulf of Mexico from Sabine Pass to Mississippi River
Pasotex Pipe Line Company El Paso, Texas	127.5	20	New loop on system from Wink to El Paso, Texas
Rangeland Pipe Line Company Calgary, Alta., Canada	450	—	Sylvan Lake Area to Sundre (Central Alberta)
	46.6	12	Northern end of Sundre field to Rangeland main line at Gilby West field
Royal Dutch Shell Group and Others The Hague, Netherlands	870	30	Marseille, France, to Rotterdam, Holland, and Antwerp, Belgium
Royal Pipe Lines, Ltd. Regina, Saskatchewan, Canada	288	Var.	Cantuar area fields to Glenavon
Shell-Standard of California	600	14	Four Corners Area to Los Angeles
Sinclair Pipe Line Company Independence, Kansas	150	20	Teague to Houston, Texas
Tecumseh Pipe Line Company Independence, Kansas	190	20	East Chicago, Indiana, to Cygnet, Ohio
Texas-New Mexico Pipe Line Company, Houston, Texas	515	16	Extension from Jal, New Mexico, pump station to Four Corners area
Trans-Border Pipe Line Company	110	—	Skagway, Alaska, to Whitehorse, Yukon Territory

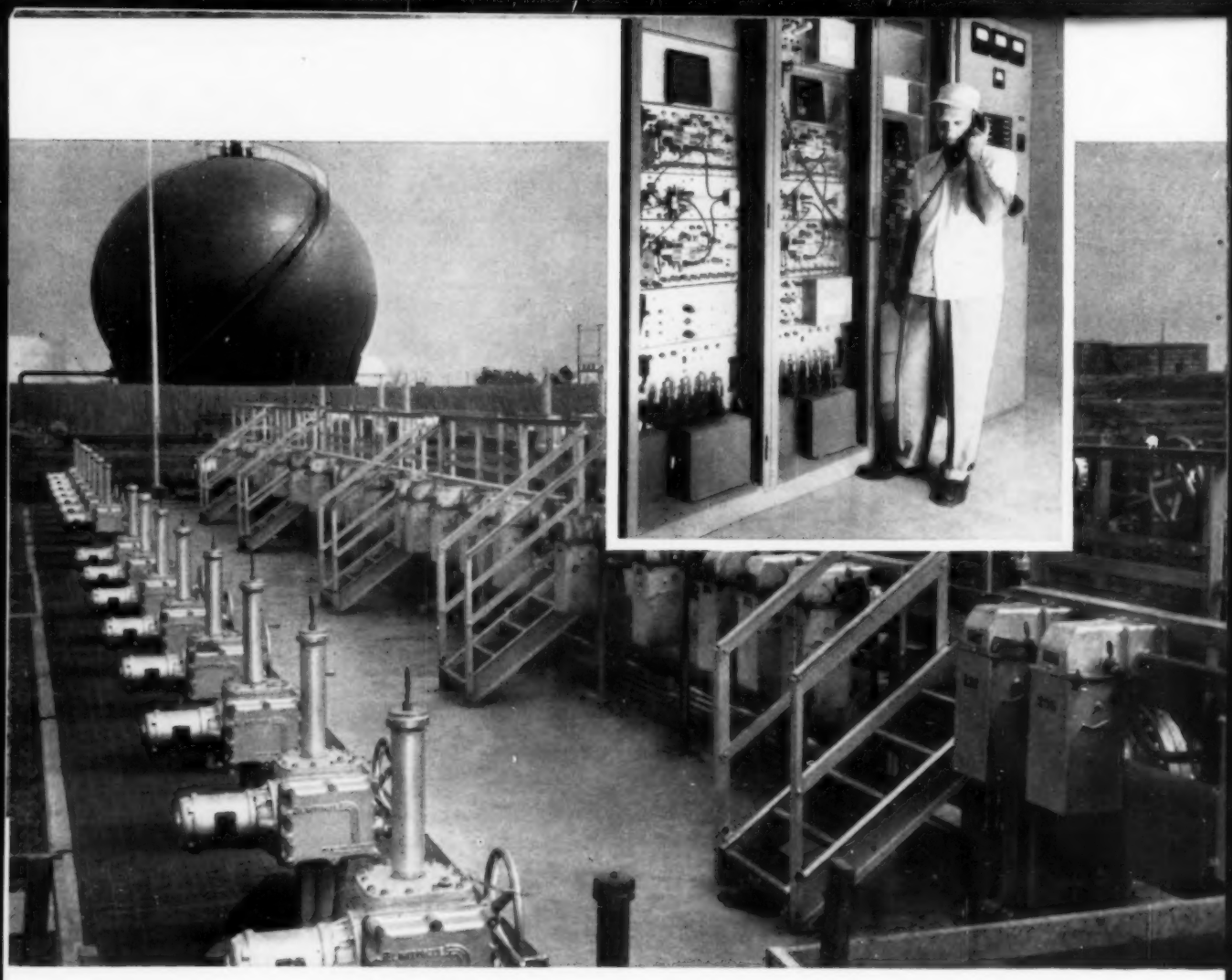
PRODUCTS LINES

Name of Company	Miles	Size	Location
El Paso Natural Gas Company El Paso, Texas	96.0	8	Gallup to Blanco Plant, New Mexico
Equitable Gas Company and Subsidiaries Pittsburgh, Pennsylvania	100	4–5	Maytown, Kentucky, to Institute, West Virginia
Great Lakes Pipe Line Company, Kansas City, Missouri	84	8	Eau Claire, Wisconsin, laterally from a point on existing lines south of St. Paul, Minnesota
	68	12	To Chicago from juncture of Great Lakes' lines with Badger system. Will supplant existing 6-in. line
Hydrocarbons Pipelines, Ltd. Winnipeg, Manitoba, Canada	800	6-8	Edmonton to Fort William, Canada
North Atlantic Treaty Organization	275	2–8	In northeastern France, between points of Langres, Mirecourt, Strasbourg, Metz, Phalsbourg and Deux Ponts
Northwest Pipeline Corporation Salt Lake City, Utah	350	8	Four Corners area to Salt Lake City, Utah
Ohio Oil Company Findlay, Ohio	—	—	Common carrier line from Wood River, Illinois, to Chicago
	—	—	Connecting line from Robinson, Illinois, refinery to new line
Service-Continental-Sinclair-Phillips	550	—	Salt Lake City, Utah, to Spokane, Washington
Texas Eastern Transmission Corporation Shreveport, Louisiana	1168	16–20	Conversion of "Little Inch" between Beaumont, Texas, and Moundsville, West Virginia
Union Oil Company of California	815	—	Shale Oil Plant, Rifle, Colorado, to Los Angeles area
Winnipeg & Central Gas Company Winnipeg, Manitoba, Canada	210	6	U. S.-Canadian border to Winnipeg

GAS LINES

Name of Company	Miles	Size	Location
Andes Pipeline Corporation	500	12	Villamontes, Bolivia, to Antofagasta, Chile
Carolina Natural Gas Corporation Hickory, North Carolina	185	2–12	Additions in North and South Carolina
Cities Service Oil Company Bartlesville, Oklahoma	70	—	Gas gathering system on the Roberts Ranch, Midland, Texas

ALLIS-CHALMERS



Complete pipeline communications and control . . . with Westinghouse Microwave

Operating your private Westinghouse communications system affords complete system control—facilities can be changed or expanded as needed. Westinghouse microwave has exclusive, advanced design features which provide:

Proved Dependability—in one complete, packaged system you can get reliable communications, plus the most advanced telemetering and remote control—an ideal partnership for efficient pipeline operation. Every component is tested for reliability, proved by thousands of hours of actual operation.

Versatility—system changes are made easily with unique multiplex units. Voice panels adapt easily to any type of telephone service; telegraph units are changed quickly from one function to another. Thirty channels available for all types of telephone or telegraphic service. For extra telegraphic service, each channel may be sub-multiplexed by as many as 15 audio tones.

Westinghouse will assume full responsibility for your microwave system . . . from survey to final approval in service. J-60901

Call your Westinghouse sales engineer to arrange a microwave system study for your pipeline, at no expense to you. Ask him for your free copy of B-5851, or write: Westinghouse Electric Corporation, Powerline Carrier and Microwave Dept., Halethorpe, Md.

YOU CAN BE SURE... IF IT'S

Westinghouse

Traveloader... revolutionizes long load handling!

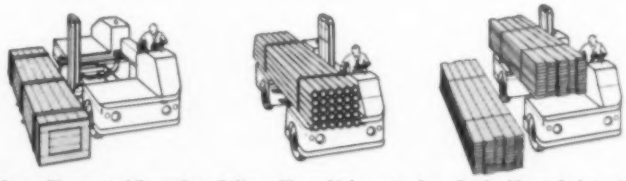
Here at last is a practical answer to the awkward problems of yard handling and particularly those nightmarish long loads. Traveloader combines the unique ability to pick up, carry and stack long, unwieldy or multiple pallet loads —indoors or out. Operating over paved or unpaved roadways, it does the job fast, safely, and much cheaper than other equipment.

This one machine, with one operator, replaces two and often three fork trucks, portable cranes or straddle carriers, and does the job better. You save manpower, cost of buying and maintaining other expensive equipment, aisle space, and time. Because Traveloader loads from the side and carries loads lengthwise, it requires much less aisle space than fork trucks.

Unlike a straddle carrier, this new machine can stack up to 12 feet high. And when traveling, the load is nested safely aboard the Traveloader's deck, eliminating dangerous dangling and swaying of load, distributing load evenly over four large wheels, and making speeds up to 30 MPH practical and safe.

Write for descriptive bulletin No. 1360.

ONLY TRAVELOADER



Picks up like a *straddle* truck • Delivers like a *highway* truck • Stacks like a *fork* truck

Baker®
industrial trucks

THE BAKER-RAULANG COMPANY
1270 WEST 80th STREET • CLEVELAND 2, OHIO
A Subsidiary of Otis Elevator Company

Otis
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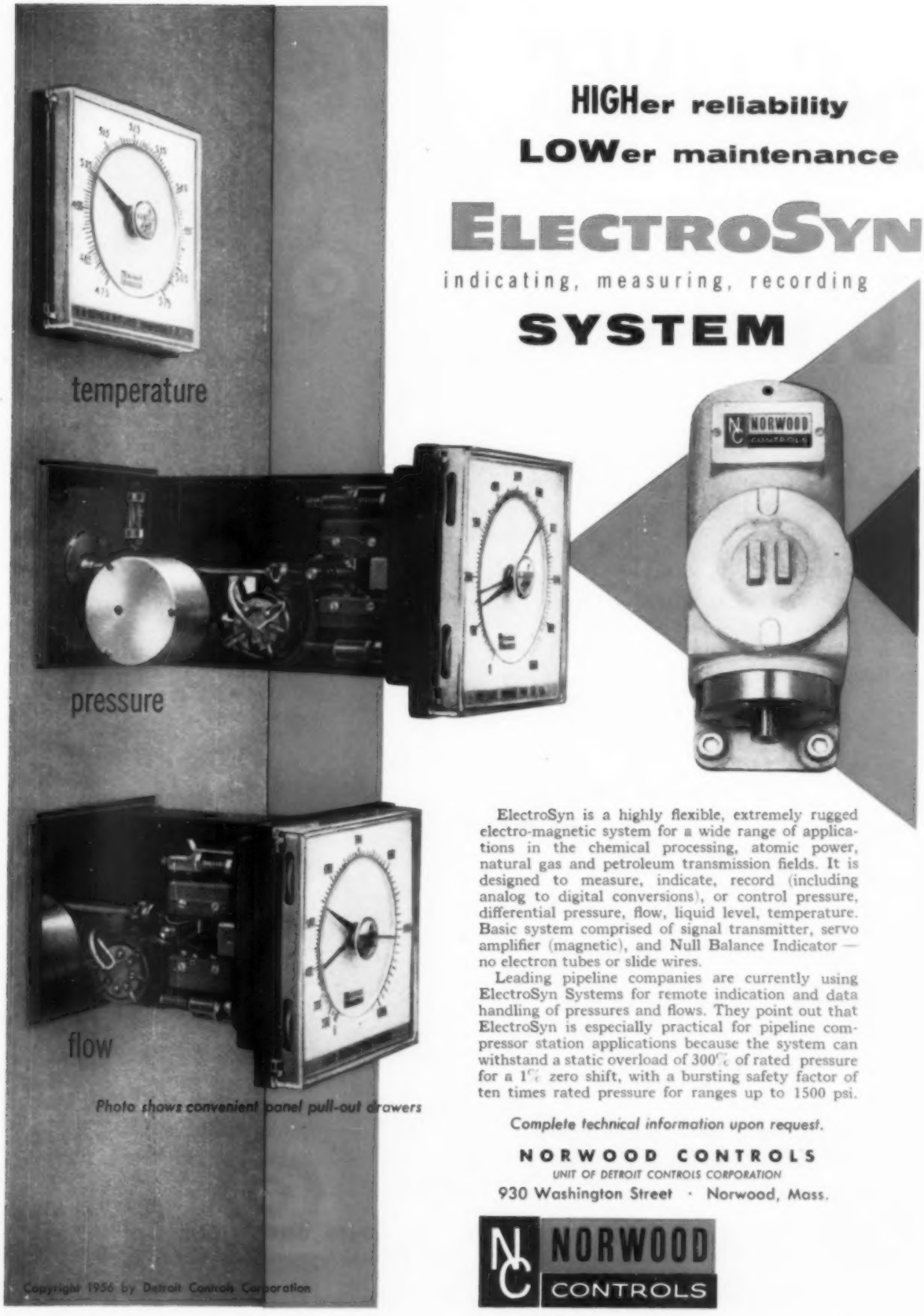
Name of Company	Miles	Size	Location
Cities Service Gas Company, Oklahoma City, Oklahoma	60	4–12	In Eureka area of Grant and Alfalfa counties, Oklahoma
Coastal Transmission Corporation Dallas, Texas	562	22–26	McAllen, Texas, to Baton Rouge, Louisiana
	272	Var.	Gathering lines in Rio Grande Valley, Texas
Colorado Interstate Gas Company Colorado Springs, Colorado	345	30	Kit Carson, Colorado, to Beatrice, Nebraska
	100	24	Springfield to Pueblo, Colorado
	50	22	Hooker to Mocane and Laverne fields, Oklahoma
	24	24	Greenwood to Panhandle-Kit Carson loop
	109	20	Loop from Fourway, Texas, to Springfield, Colorado
	106	24	Loop from Springfield to Kit Carson, Colorado
	10	16	Keyes field, Oklahoma, to mainline
	6	10	Tablerock field, Wyoming, to mainline
	48.0	4–16	Additions in Mocane field, Oklahoma
	12.0	12–22	Additions in Texas Panhandle fields
El Paso Natural Gas Company El Paso, Texas	83.8	34	Loops to San Juan mainline extending from San Juan County, New Mexico, to Topock, Arizona
	20.5	30	Loops to existing Permian-San Juan mainline from Bluewater station to San Juan mainline in McKinley County, New Mexico
	8.3	26	Loops to California mainline in Yuma County, Arizona
	28.5	30	Field transmission line in San Juan Basin, New Mexico
	78.8	18	Field line from Carson County, Texas, to Moore County, Texas
	22.5	20	South Andrews field booster station to plant
	8.5	16	Shell plant to Goldsmith station
	290	—	To deliver additional gas to three California customers. New gas to come from San Juan Basin and Panola and Permian Basin fields in Texas.
Houston Texas Gas & Oil Company Houston, Texas	961	12-30	Baton Rouge, Louisiana, to Miami, Florida, laterals
Kansas-Nebraska Natural Gas Company Phillipsburg, Kansas	61.3	var.	Gathering lines from Camerick field to Liberal, Kansas
Kansas-Nebraska Natural Gas Company, Inc. Hastings, Nebraska	10	10	Grand Island to Fullerton, Nebraska
	10	8	Loop from Grand Island to Fullerton, Nebraska
	11.5	12	Replacement from Scott City to Oakley, Kansas
	1.2	6	Additions to system in Nebraska
	9	8	Lexington to Central Nebraska Public Power Electric Plant
	14	16	Replacement from North Platte to Maxwell, Nebraska
Michigan Wisconsin Pipe Line Company Detroit, Michigan	31	4-6	Looping in Michigan and Indiana
Midwestern Gas Transmission Company	1112	12–24	Mainline from U. S.-Canadian border near Emerson, Manitoba — Noyes, Minnesota, to Portland, Tennessee
	648	3–18	Laterals of mainline to serve communities in Minnesota, North Dakota and Wisconsin
Natural Gas Pipeline Company of America Chicago, Illinois	349	20–26	Jack and Wise counties to Fritch, Texas
	38	36	Joliet to Elgin, Illinois
	405	36	Beaver County, Oklahoma, to Joliet, Illinois (loops)
	25	—	Gathering line from Quinduna field, Roberts County, Texas, to point on existing line
	91	30	Loops in Nebraska, Kansas, Oklahoma
Northern Natural Gas Company Omaha, Nebraska	28	24	Ogden to Redfield storage area, Iowa
	168	20	St. Paul-Minneapolis to Duluth, Minnesota, and Superior, Wisconsin
	307	Var.	Branch lines in South Dakota, Minnesota, Iowa and Wisconsin
	100	20–24	Savannah Creek field, Alberta, to Alberta-Montana border near Cardston, Alberta
Northern Plains Natural Gas Company (subsidiary of Northern Natural Gas Company) Omaha, Nebraska	1100	26	Alberta-Montana border to Minneapolis, Minnesota
Offshore Gathering Company Houston, Texas	364	30	Offshore gas line in Gulf of Mexico from Sabine Pass to Mississippi River
Pacific Gas & Electric Company San Francisco, California	200	12	Glenn and Tehama counties to Eureka and Arcata, California
Pacific Lighting Gas Supply Company Los Angeles, California	80	30	Coles Levee to Newhall
	2.1	16–20	Potrero to Newhall
	2.8	16	Lines in East Whittier
Tennessee Gas Transmission Company Houston, Texas	100	—	New gathering lines in Texas and Louisiana
	557	30	Mississippi River Delta south of New Orleans to Portland, Tennessee
	120	12,20,26	Kinder, Louisiana, south 68 miles into Gulf of Mexico
	332	24–30	Loops in Kentucky, West Virginia, Pennsylvania, Tennessee
	76	24	Coudersport, Pennsylvania, to Buffalo, New York
	299	var.	Adding to existing systems in Ohio, Pennsylvania, Kentucky, Texas and Louisiana
Texas Eastern Transmission Corporation Shreveport, Louisiana	530	30	Loops from Kosciusko, Mississippi, to Uniontown, Pennsylvania
	10	12	Loop from Broadaxe Junction to Levick Street, Philadelphia, Pennsylvania
	6	12	Loop from Broadaxe Junction to Conshohocken, Pennsylvania
	5	10	South Plainfield to Highland Park, New Jersey
Texas-Illinois Natural Gas Pipeline Company Chicago, Illinois	59	20	Joliet to Volo, Illinois
Trans-Canada Pipe Lines, Ltd. Calgary, Alberta, Canada	1675	30–34	Winnipeg to Montreal and laterals
Transcontinental Gas Pipe Line Corporation Houston, Texas	350	24,30,36	Louisiana, Mississippi, Alabama, Georgia, South Carolina, North Carolina, Virginia, Maryland, Pennsylvania



HIGHer reliability

LOWer maintenance

ELECTROSYN

indicating, measuring, recording

SYSTEM

ElectroSyn is a highly flexible, extremely rugged electro-magnetic system for a wide range of applications in the chemical processing, atomic power, natural gas and petroleum transmission fields. It is designed to measure, indicate, record (including analog to digital conversions), or control pressure, differential pressure, flow, liquid level, temperature. Basic system comprised of signal transmitter, servo amplifier (magnetic), and Null Balance Indicator — no electron tubes or slide wires.

Leading pipeline companies are currently using ElectroSyn Systems for remote indication and data handling of pressures and flows. They point out that ElectroSyn is especially practical for pipeline compressor station applications because the system can withstand a static overload of 300% of rated pressure for a 1% zero shift, with a bursting safety factor of ten times rated pressure for ranges up to 1500 psi.

Complete technical information upon request.

NORWOOD CONTROLS

UNIT OF DETROIT CONTROLS CORPORATION

930 Washington Street · Norwood, Mass.

NC NORWOOD CONTROLS

BIG LINES take BIG VALVES

This 34" ASA-400 full opening high pressure Grove *Seal-O-Ring* Gate Valve with the fabricated steel body is one of a series already in service on one of the nation's major gas pipelines. Its huge free-sliding non-wedging gate is actuated by a hydraulic piston operating on pressure from the line. Grove *Seal-O-Ring* Gate Valves – now thoroughly proved in the field – are available from 2" to 36" in all standard pipeline pressures for gas or liquid service.

THE WHOLE VALVE IS RIGHT HERE

When valve is full open or closed, bubble-tight seals on both sides of the gate completely isolate line pressure in the conduit. The body, serving merely as framework for operating mechanism and to prevent loss of product while gate is in motion, may be drained or vented to atmosphere when gate is open or closed. Integrity of seals can be checked any time by a tell-tale valve on the body.

701

GROVE SEAL-"O"-RING Gate Valves

SUBSIDIARY OF WALWORTH

GROVE VALVE and REGULATOR COMPANY • 65th & Hollis Sts., Oakland 8, Calif.
HOUSTON 4—1901 Calumet St. • • • • • **LOS ANGELES 6**—1930 W. Olympic Blvd.

GROVE SEAL O RING ® GROVE SIMPLICITY ACCURACY SAFETY

ODESSA, TEXAS • TULSA, OKLAHOMA • DENVER, COLORADO • In Western Canada: GROVE VALVE LIMITED

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Typical installation of American Hammered Conformable Oil Rings

AMERICAN HAMMERED CONFORMABLE OIL RING

Insures constant unit pressure for positive oil control!

You keep your oil consumption down when you install Koppers American Hammered Conformable Oil Rings! This service-tested piston ring conforms readily to meet cylinder distortion because its flexible cast iron member is pressed outward by an abutment type spring which exerts uniform radial pressure around the entire circumference.

Narrow bearing surfaces on either side of the channel give the ring a uniform unit pressure on the cylinder, enabling it to seat promptly and assuring maximum removal of excess oil throughout its lifetime. And the Conformable Oil Ring has a longer useful life because its low spring rate and uniform lands result in negligible changes in pressure as the ring wears.

Easily installed, it is ideal for both 2-cycle and 4-cycle Diesel & Gas engines; comes in 4" to 25" diameters with a minimum width of ¼". Write, wire or phone us today for full information on how the Conformable Oil Ring can improve *your* operation . . . or for expert help in *any* piston or sealing ring problem. KOPPERS COMPANY, INC., *Piston Ring Dept.* 1702 Hamburg Street, Baltimore 3, Maryland.

KOPPERS®

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • Baltimore, Maryland

This Koppers Division also supplies industry with Fast's Couplings, Aeromaster Fans, Koppers-Elex Electrostatic Precipitators and Gas Apparatus.

Engineered Products Sold with Service

AMERICAN HAMMERED *Industrial Piston Rings*

KOPPERS COMPANY, INC., *Piston Ring Dept.*, 1702 Hamburg Street, Baltimore 3, Md.

Gentlemen: Please send me full information on your Conformable Oil Ring.

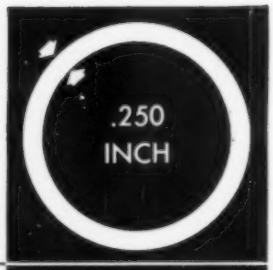
Name .....

Company .....

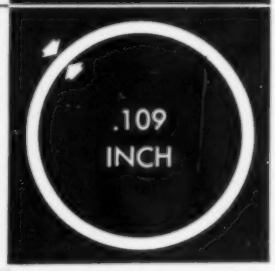
Address .....

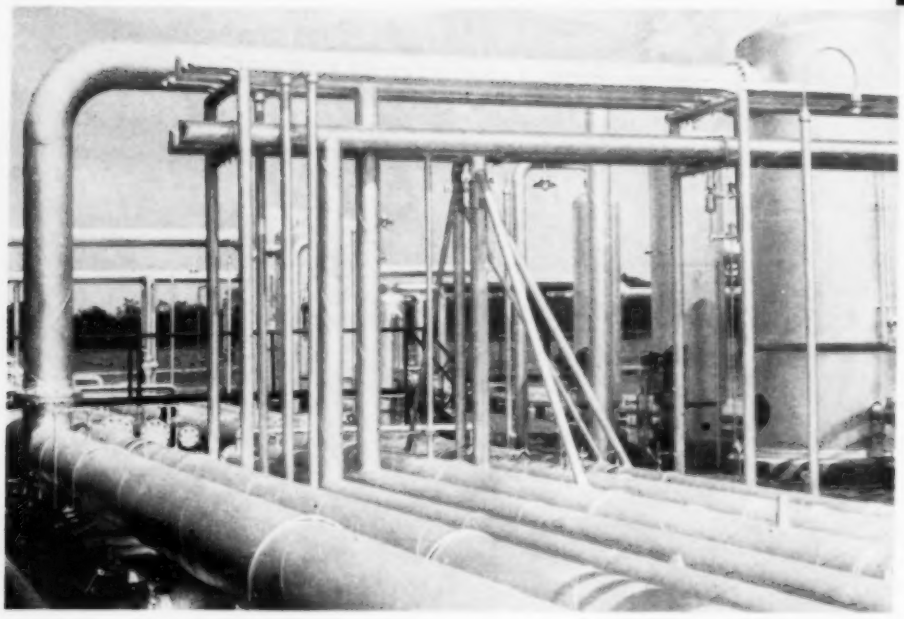
City ..... Zone ..... State .....

Why pay extra for this.....



When you need only this.....





Armco supplies Welded Steel Pipe to meet requirements in the Natural Gasoline and Natural Gas Divisions and wherever else you need dependable line pipe.

When your pipeline calls for light wall pipe, you can easily get what you need from the wide range of wall thicknesses available in Armco pipe.

Many lines such as gas gathering lines for natural gasoline plants, gasoline plant piping, and residue gas lines do not require expensive, heavy wall pipe. Yet the lightest wall pipe available from many suppliers is ¼-inch wall thickness.

Armco Pipe is supplied in many thicknesses from $^{9}/_{64}$- to ½-inch. You select what you need without paying for excess metal. Also, you can choose from 20 different diameters of Armco Pipe, ranging from 6 to 36 inches.

WRITE FOR DATA

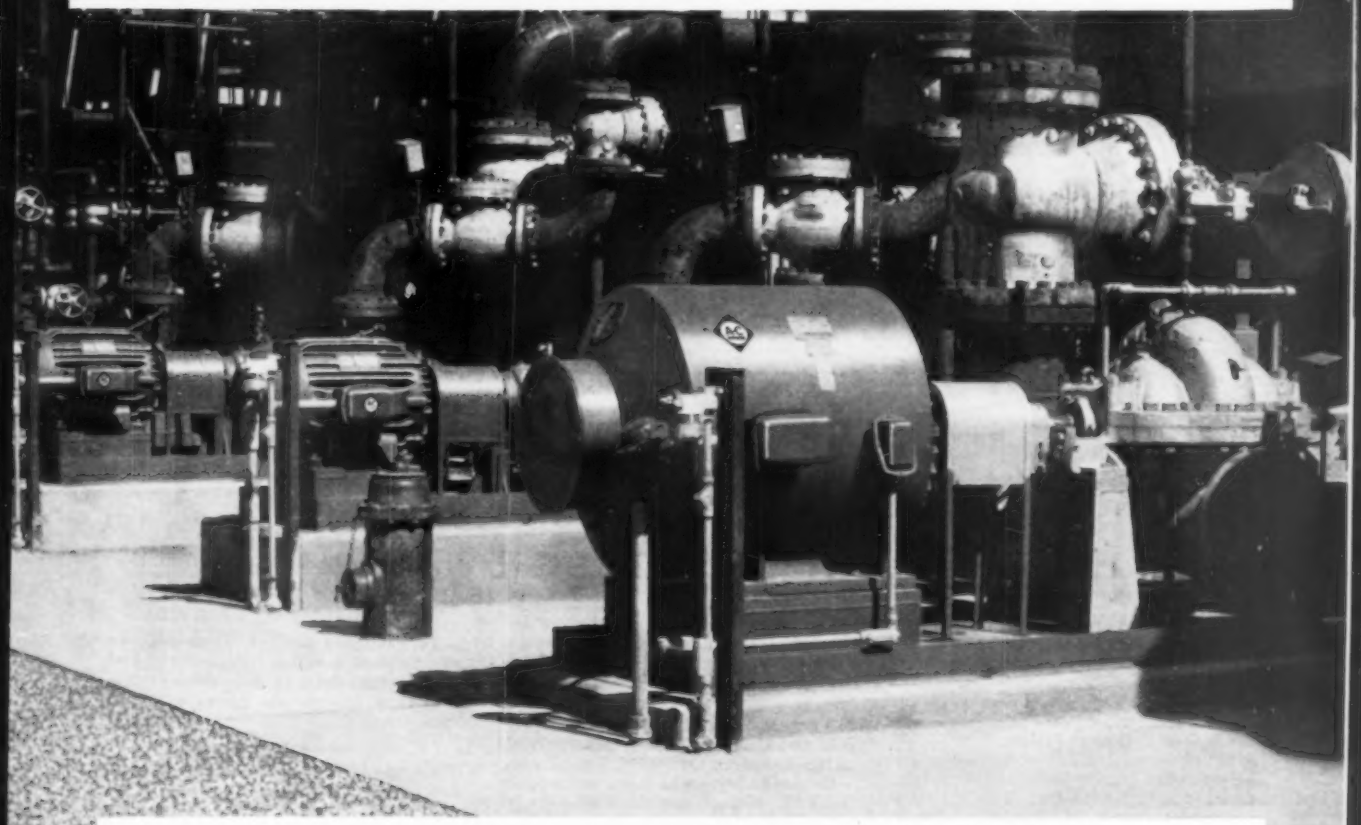
Write for complete information applied to your needs. Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division, 3647 Curtis Street, Middletown, Ohio. 201 KOME Building, Tulsa, Oklahoma. Subsidiary of Armco Steel Corporation. Export: The Armco International Corporation.

ARMCO WELDED STEEL PIPE

for more continuous processing—

Another great refinery installs

ALLIS-CHALMERS MOTORS



Thousands of horsepower in Allis-Chalmers motors will drive processing equipment at Tidewater Oil Company's new Flying A Refinery, near Delaware City, Delaware.

Designed and constructed by C. F. Braun & Co., engineers and constructors, this plant will process 130,000 bbl of crude oil per day. The largest ever built in a single construction operation, this huge refinery joins a growing list of major petroleum plants in which Allis-Chalmers equipment is used. Main reason for this trend:

Continuous Operation

- **Ribbed Construction** of smaller motors gives up to 43% more cooling surface when compared with ordinary motors. *Tube-Cooled* design in larger sizes permits free flow of air. BOTH designs result in fewer winding burnouts.

- **Motors** are of the chemical type, designed for use in refinery operations.

- **Stators** receive more than the usual dips and bakes. They get extra dips and bakes plus two coatings of red enamel to provide maximum electrical life.

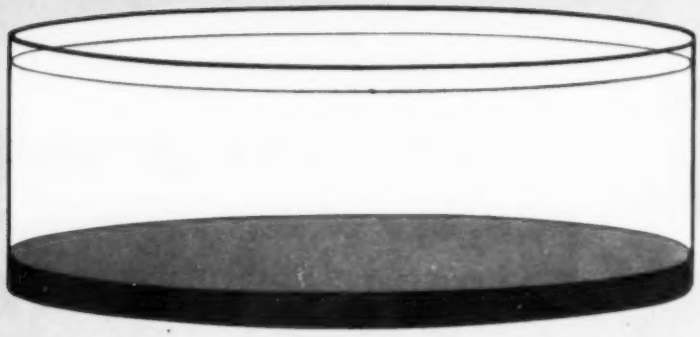
* * *

FIND OUT MORE about Allis-Chalmers motors for the petroleum industry. Contact your nearby A-C sales office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

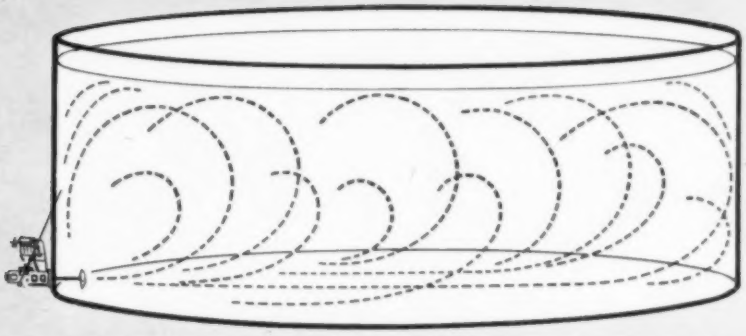
ALLIS-CHALMERS

A-C ALLIS CHALMERS

A-5185



THE EXPENSIVE WAY—If you let sludge pile up in your tank bottoms, you're probably paying much more than you realize for sludge control. Actual tank cleaning cost is only part of the story.



THE LIGHTNIN WAY—You actually save money when you keep tanks free of sludge the easy way, by flipping a switch. Read why LIGHTNIN control of BS&W may save you as much as $1,000 per tank per year.

How do you control SLUDGE?

You can make a one-time investment that will eliminate *for good* the expense and mess of cleaning out sludge in your crude oil tanks.

Just take the money you plan to spend for sludge cleanout in the next year—and invest it in LIGHTNIN Mixers.

How much can this save you on overall operating cost? Careful field tests, by a large pipe line company, show a direct, traceable saving of *$1,000 per tank per year.*

Why you save 3 ways

1. Every time you have to clean out a tank, you spend just about enough to cover the cost of a LIGHTNIN Mixer. With a LIGHTNIN in the tank, you can keep sludge suspended in the crude, or resuspend it if it has settled. You can maintain as little as *one inch* of sludge level in the tank bottom, year after year.

2. You can keep full holding capacity of your tankage ready to use when you need it. No downtime for cleaning out sludge—no sludge pile-up to waste tank capacity. Add as much as *12% more capacity* without adding a single tank.

3. You realize *full value* on the crude you handle. Crude leaving the tank contains the same values as when it entered the tank. With LIGHTNIN Mixers, you can make every barrel in the tank merchantable crude oil.

To get these savings, more than 50 independent pipe line companies and 35 leading producers and refiners use LIGHTNIN Mixers for crude oil sediment control.

What can you save?

Want specifics on what *you'll* save with LIGHTNINs in your tanks? Your LIGHTNIN Mixer representative can give them to you. For quick, competent help, phone him today. (He's listed in your copy of Composite Catalog.) Or write us direct.

Lightnin® Mixers

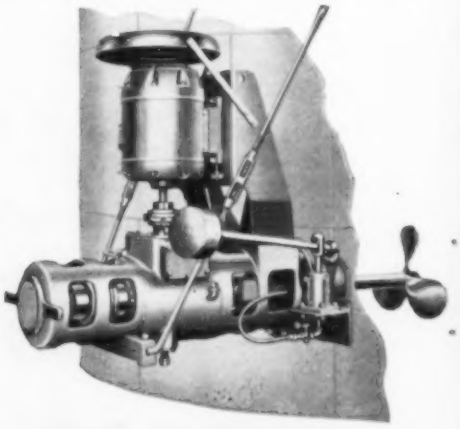
MIXCO fluid mixing specialists

Get these helpful bulletins on BS&W control and LIGHTNIN Mixers. Check, tear out and mail to us today with your name and company address. Free—no obligation.

- ☐ B-503 BS&W Control with LIGHTNIN Mixers
- ☐ B-104 Side entering mixers, 1 to 25 HP
- ☐ B-107 Data sheet for figuring mixer requirements
- ☐ B-109 Condensed catalog describing LIGHTNIN Mixers—all types
- ☐ B-111 LIGHTNIN rotary mechanical seals for extra-low-cost mixing

MIXING EQUIPMENT Co., Inc., 127-b Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Avenue, Toronto 10, Ont.



YOU CAN GET LIGHTNIN Mixers in sizes from 1 to 25 HP, to control bottom sediment in any tank, new or old, regardless of tank capacity.

EXTRA MILES...

WITH PEAK MOBILE RADIO POWER

☆ 100 WATT POWER OUTPUT ☆ MAXIMUM RANGE
☆ EXTENDED COVERAGE ☆ TOP RECEIVER SENSITIVITY

Motorola "TWIN-V" radiophone—with highest power, to push the range of your VHF radio system to its maximum—to optimize mobile-to-base and mobile-to-mobile communications in the farthest fringe areas.

Here peak receiver sensitivity combines with highest transmitter output to assure dependable reception of all communications. Advanced design provides full 100 watt rated output. Yet the economical battery drain is comparable to conventional 60 watt equipment—plus full 6/12 volt interchangeable operation, without changes or modifications, for obsolescence protection in mixed fleets.

The 25-54 mc. 100 watt mobile radio equipment includes all the forward-looking engineering of the "TWIN-V" radiophone line:

- **Conservative long-life design**
- **Reserve performance**
- **Minimum maintenance requirements**
- **"On-channel" stability**
- **Crisp, clear voice reproduction**
- **Rugged construction**
- **Dependability through the years**

Twin-V RADIOPHONE 6 12

These and many other features have made "TWIN-V" radiophone the choice of most mobile radio users—features which become more strikingly evident as experience continues to prove their merits.

And Motorola is your *complete* supplier—with the proper equipment for every radio system, plus parts, maintenance, financing, service and engineering available for every application. Write, phone or wire—TODAY!

MOTOROLA

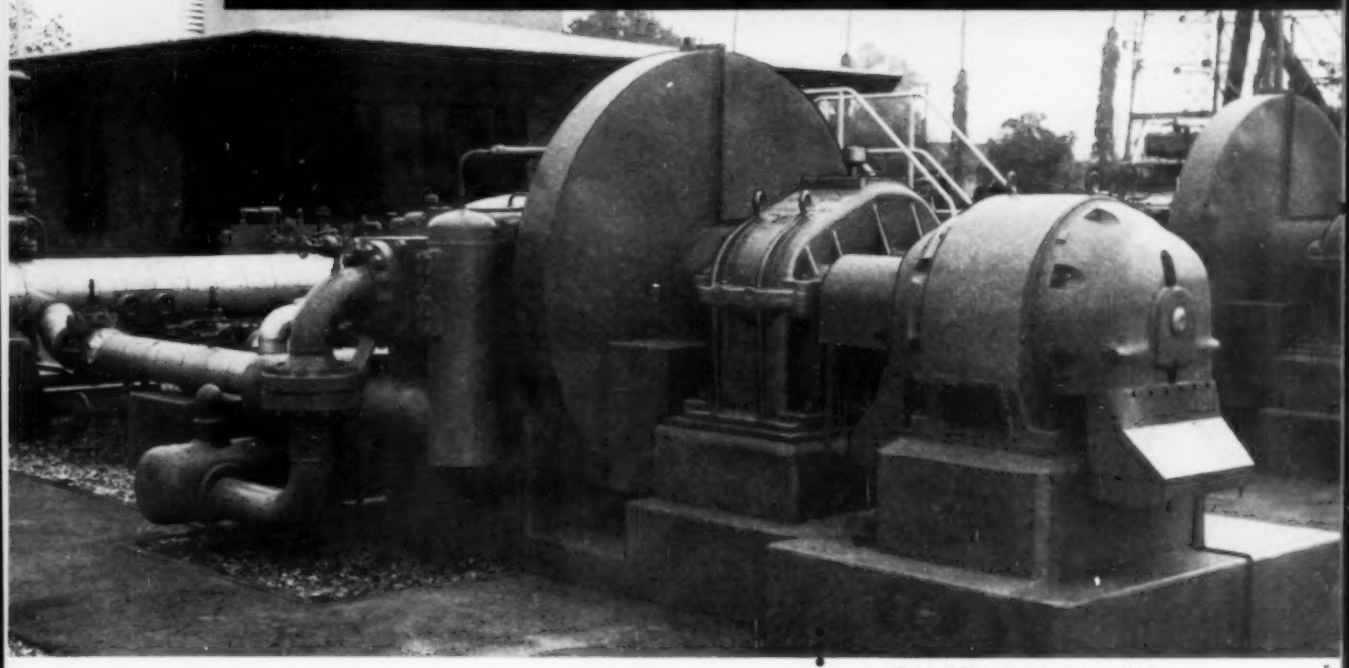
2-WAY RADIO

MOTOROLA COMMUNICATIONS & ELECTRONICS, INC.
A SUBSIDIARY OF MOTOROLA, INC.
4501 AUGUSTA BOULEVARD • CHICAGO 51, ILLINOIS

Motorola consistently supplies more mobile and portable radio than all others combined.
Proof of acceptance, experience and quality.
The only COMPLETE radio communications service—specialized engineering . . . product . . . customer service . . . parts . . . installation . . . maintenance . . . finance . . . lease.
"The best costs you less—specify Motorola."

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

12 WESTERN GEAR reducers operate 200°f fuel pipeline



Typical Western Gear installation in one of three Edison pipeline stations

By J. E. BAILEY
Industry Specialist-Petroleum
Western Gear Corporation

Twelve Western Gear speed reduction gears, Model S-63, were wisely selected for the three Edison pipeline stations whose unusual job is to pump 200° F. fuel oil along the 41 mile, eight inch line. Western Gear 6:1 reduction gears driven by 150 HP electric motors, power Cooper-Bessemer reciprocating pumps. The line, engineered and constructed by the Bechtel Corporation to transport fuel to a Southern California Edison Company steam electric generation station, has been operated by General Petroleum since 1952. The Western Gear reducers have been completely trouble-free in operation. This record of Western Gear reliability has been repeated in hundreds of pipeline stations throughout the United States. Complete engineering assistance is available, no obligation. Why not call Western Gear now? Write on company letterhead for new Bulletin No. 5204. Address General Offices, Western Gear, P.O. Box 182, Lynwood, California.

pipeline facts

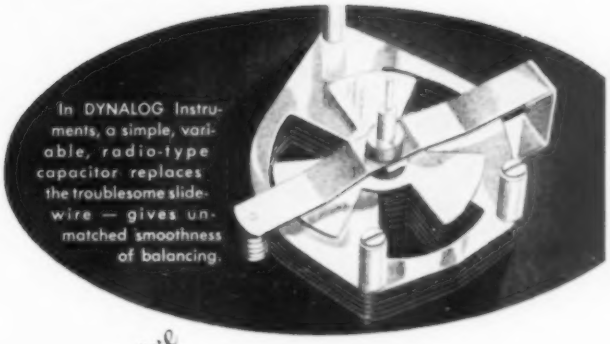
Fuel oil with a viscosity of 175/185 SSF at 122° F. is heated to 200° and started in the line at the Santa Fe Springs pumping station (see photo) and then directed onwards to the Tonner station and the Euclid station. Each station reheats the oil and the pumping cycle is repeated. The fuel is pumped into storage tanks at the steam station site. The pipeline, designed for 1,000 lbs. maximum pressure, is operated at 650 lbs. pressure at a normal pumping rate of 650-750 barrels per hour. Light oil replaces the heavy fuel oil in the line prior to shutdowns. Elevation of the line varies from 162 to 1200 feet above sea level.

"The difference is reliability" • Since 1888

5640

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.)
SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS



In DYNALOG Instruments, a simple, variable, radio-type capacitor replaces the troublesome slidewire — gives unmatched smoothness of balancing.

This potentiometer has no slidewire

STEPLESS CAPACITY-BALANCING

ELIMINATES SLIDEWIRE MAINTENANCE

DYNALOG'S* EXCLUSIVE BALANCING ACTION

- no slidewire
- no batteries
- no standardizing
- no gears, cables, etc.
- no high-speed reversing motor

There's no need to put up with worn slidewires and sticking electrical contacts . . . no need to periodically clean and lubricate balancing motors. DYNALOG design eliminates all this! Its simple variable capacitor and positive magnetic drive provide *continuous, stepless* balancing . . . *never* require attention!

DYNALOG's friction-free action provides high speed of response without wear. (There are only five moving parts, including the recording pen!) Sensitivity, unlimited by turns of slidewire winding, is 1/100 of 1%. And accuracy is a sustained 1/4 of 1%.

DYNALOG Instruments are available for use with resistance, voltage, capacity, or inductive type primary elements to measure and/or control any process variable . . . with unmatched smoothness. Write for Bulletin 427. The Foxboro Company, 382 Norfolk St., Foxboro, Mass., U.S.A.

*Reg. U.S. Pat. Off.

FOXBORO

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DYNALOG

ELECTRONIC INSTRUMENTS

the BUCYRUS ERIE 30-B

. . . sets new performance standard in the 1-yd. class

Here's a brand new 1-yd. profit-maker for you — the Bucyrus-Erie **30-B**. Offered with either crawler or rubber-tired carrier mounting, it's readily convertible from hoe for trenching to clamshell or dragline for ditch cleanout.

New . . . fast . . . quality-built, the **30-B** is just what you need in a 1-yd. machine to get ditch in a hurry. Check the brief rundown of features given below; then request full details.

Matched to your needs

- Your choice of diesel, gasoline, or single-motor electric power. Direct or torque converter drive.
- Five easily-converted front ends — shovel, dragshovel, crane, dragline and clamshell.
- Your choice of five crawler mountings *plus* independent propel (available as extra equipment).
- Auxiliary A-frame on hoe has telescopic strut which prevents "kicking back" when digging trench on steep grades.

Designed to out-perform

- Easy, air control for smooth, big-output working cycles.
- Easy to service — automatic lubrication of many parts.
- Large, cool-running clutches and brakes.

Built to outlast

- Six conical hook rollers distribute loads evenly between upper and lower works to save wear.
- Five main operating clutches are alike, with parts interchangeable.
- Specially-processed steels add strength and wear resistance.
- Strong, rigid cast revolving frame withstands twisting and bending stresses, maintains machinery alignment.

234E56C

BUCYRUS-ERIE COMPANY
South Milwaukee, Wisconsin

BUCYRUS-ERIE COMPANY
South Milwaukee, Wisconsin

Gentlemen: Please send me details on the new 30-B.

Name _____

Organization _____

Address _____

City _____ State _____

234E56C

Send for complete facts NOW!

Buried any treasure lately? If so, did you protect it with BLUE FLAG?

Don't let underground corrosion rob your company of huge pipeline investments. For less than one-half of one per cent of the original cost, you can protect pipelines with Blue Flag Pipe Wrap.

L·O·F Glass Fibers' Blue Flag is made of special inert glass which resists the destructive action of soil chemicals. A Blue-Flag reinforced coating will extend pipeline-life years longer than unreinforced coatings.

What's more, Blue Flag greatly increases wrapping efficiency. High tensile strength virtually eliminates breakage . . . uniform porosity keeps "holidays" to a minimum . . . enamel cold flow is retarded, while strength is increased . . . pipeline coating is protected from backfill damage.

Blue Flag Reinforcing Pipe Wrap is available from a nearby distributor-warehouse. For full details, write: L·O·F Glass Fibers Company, Dept. 72-27, 1810 Madison Avenue, Toledo 1, Ohio.

LOF GLASS FIBERS
BLUE FLAG
PIPE WRAP

L·O·F GLASS FIBERS COMPANY
TOLEDO 1, OHIO

For Complete Pipeline Protection, use: BLUE FLAG Reinforcing Pipe Wrap • **DURAMAT** Protective Outer Wrap • **DURAMESH** Pipeline Fabric • **DURATAPE** Pipeline Joint Wrap

Hourly pressure information is transmitted from Northern Natural Gas Company compressor and field dispatch station to chief dispatcher's office in Omaha, Nebraska, by Bell System private line telephone.

How they protect 800,000 homes from a sudden temperature drop

There's a sudden drop of temperature in the Dakotas—and dispatchers of the Northern Natural Gas Company swing into action—to assure normal gas pressures for local distributing companies serving 800,000 domestic users through 10,000 miles of pipeline all the way from New Mexico to Minnesota!

Dispatchers, using Bell System private line telephone facilities, arrange to have certain large industrial users switch temporarily to other fuels.

Then, through contact with 35 compressor stations by telephone, dispatchers at Omaha headquarters direct the additional gas thus gained to the desired localities. A potential emergency is handled in stride, thanks to modern communications.

• • •

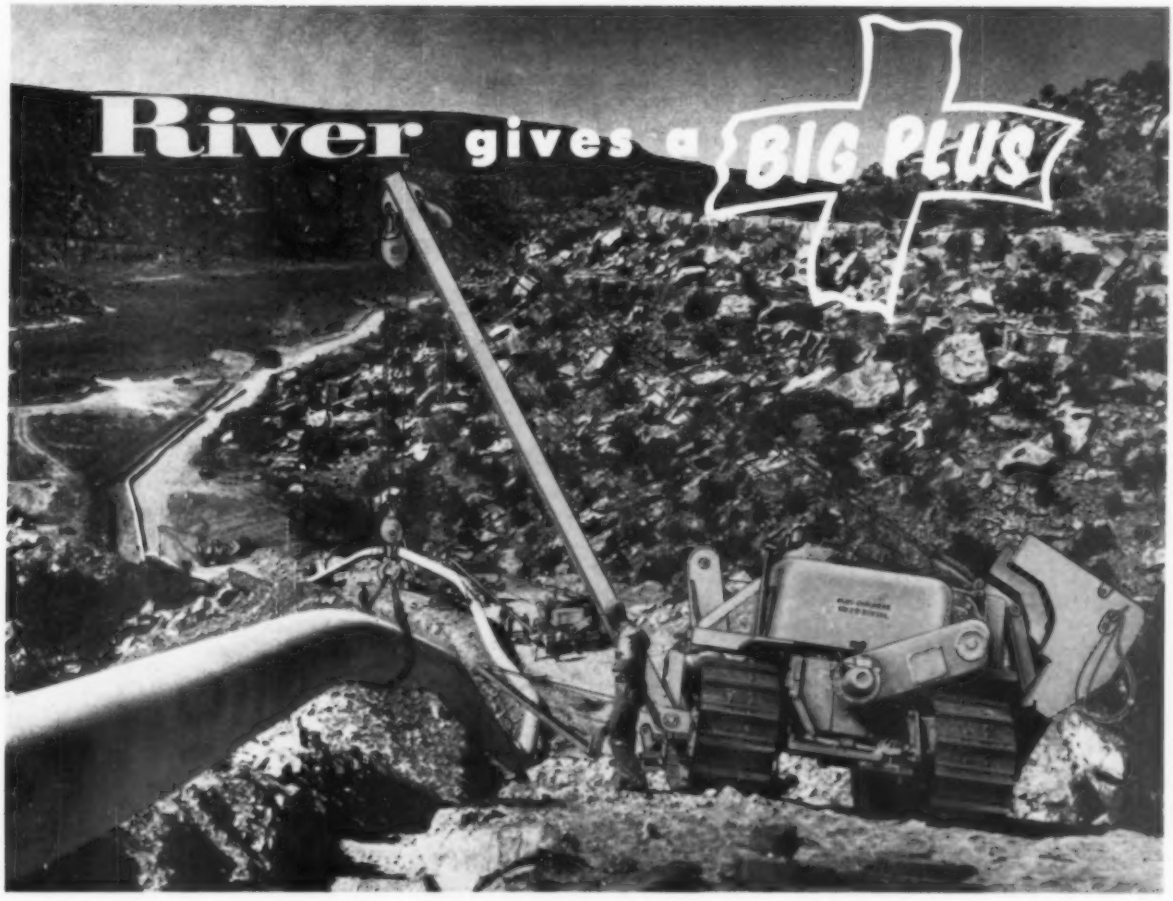
The Bell System welcomes the opportunity to help you obtain the most reliable and economical communications facilities. Call your Bell System representative.

BELL TELEPHONE SYSTEM

PRIVATE LINE TELEPHONE • PRIVATE LINE TELETYPEWRITER

CHANNELS FOR: DATA TRANSMISSION • TELEMETERING • REMOTE CONTROL • TELEPHOTOGRAPH • CLOSED CIRCUIT TV

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



to your pipeline contract

When River is on the job you get the plus value of over 20 years experience in building pipelines of all sizes in all kinds of terrain and weather.
From this experience comes the planning, equipment and trained crews needed to get the job done right and on time.
River experience has licked mountains and plains . . . lakes, rivers and deserts.

Put River to work on your contract and watch the job finished on time.
River is just the right size . . . big enough to handle any job . . .
small enough to give your contract the personal attention it deserves.

River CONSTRUCTION CORPORATION

Robert Thomas
J. C. Briscoe
J. C. Minyard

GENERAL OFFICES: 4837 WEST FREEWAY, P. O. BOX 9127 • FORT WORTH, TEXAS

Wholly Owned Subsidiary: RIVER CONSTRUCTION CORP., LTD., 580 Hornby, Vancouver, British Columbia, Canada

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

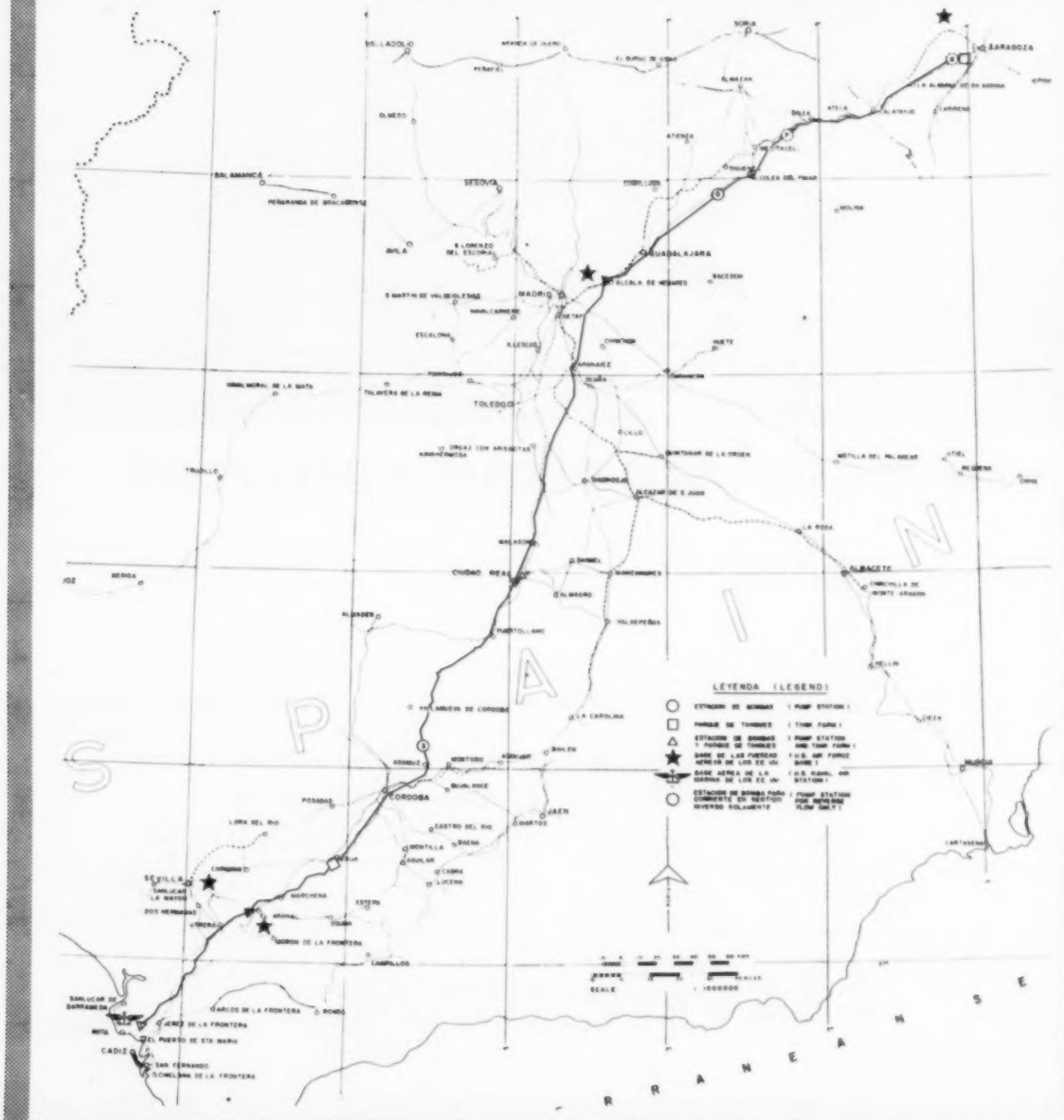
Spanish Pipe

Reversal of flow, blast-resistant tank construction, among features of products system to fuel inland American air bases.

Earle Corliss

U. S. Department of Navy, Bureau of Yards and Docks

Route of Spanish pipeline, location of air bases, pumping stations, and tank farms.



Line Designed For Full Mobilization

THE supply of aircraft fuels to support activities at the U. S. air bases presently being constructed near San Pablo, Moron de la Frontera, Torrejon, and Zaragoza in Spain was recognized in the early planning stages to be a major logistic problem, measured in terms of existing transportation facilities in Spain. From a logistics standpoint, the supply of fuels to these new Air Force bases in sufficient quantities to serve a mobilization requirement could be provided only by a products pipeline from a deep water port.

The Navy plan for facilities in Spain included a deep water harbor, Naval air facility, storage facilities, a petroleum fuel terminal, and other installations near the village of Rota in the Bay of Cadiz. In view of the obvious economy that would result from point use of the Navy terminal at Rota, the plan for development was expanded to permit receipt and transfer of Air Force fuels to serve inland bases. (See map.) The pipeline, now under construction, begins at Rota and terminates near Zaragoza, nearly 500 miles to the northeast.

The Bureau of Yards and Docks is the engineering and construction agent for the entire U. S. Military construction program in Spain, both Navy and Air Force. In the case of Air Force facilities, however, of which the products pipeline is one element, the criteria or performance requirements are supplied to the Navy's officer in charge of construction as a basis for design. In some respects this products pipeline is based upon different criteria than would be the case in similar projects of industry.

Products to be transported through the line are aircraft jet engine fuel, aircraft reciprocating engine fuel, motor gasoline, and diesel engine fuel.

The range of flow rates, as between a peacetime consumption and the requirements for a period of mobilization effort, are extremely wide. Inasmuch as the construction of facilities for any armed service of a country are primarily based upon a mobilization effort, it follows that the peacetime use of the products pipeline in Spain, with low rates of consumption, presents an operational problem of using the system at low rates of fluid flow. To solve the problem the line will be operated for limited periods at rated capacity in order to maintain turbulent flow and thereby minimize interfacial mixing of products.

A tank farm location showing tanks in various stages of completion.

Reverse Flow Required

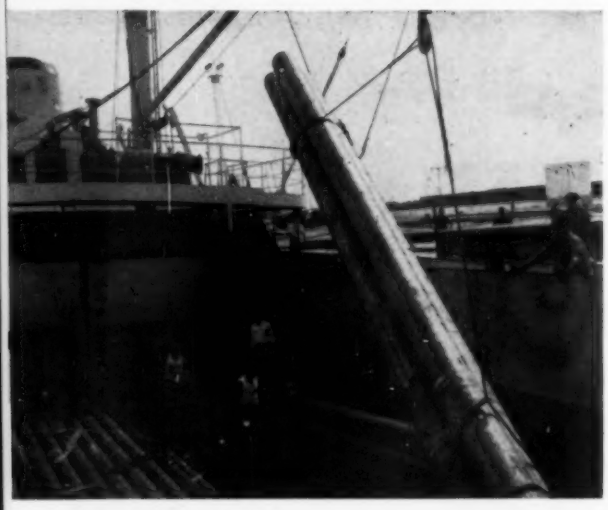
Another requirement is that the pipeline system be capable of reverse flow between pumping stations. Under such an arrangement, if the line is ruptured at a point because of enemy action, fuels in storage in the northeast end of the system can be moved southwestward as far as the break to supply stations requiring such fuel.

The pipeline is 12-in. nominal size between Rota and the No. 3 pump station at Adamuz, 10-in. between Adamuz and the No. 5 pump station at Torrejon, and 8-in. from Torrejon to the Zaragoza terminal.

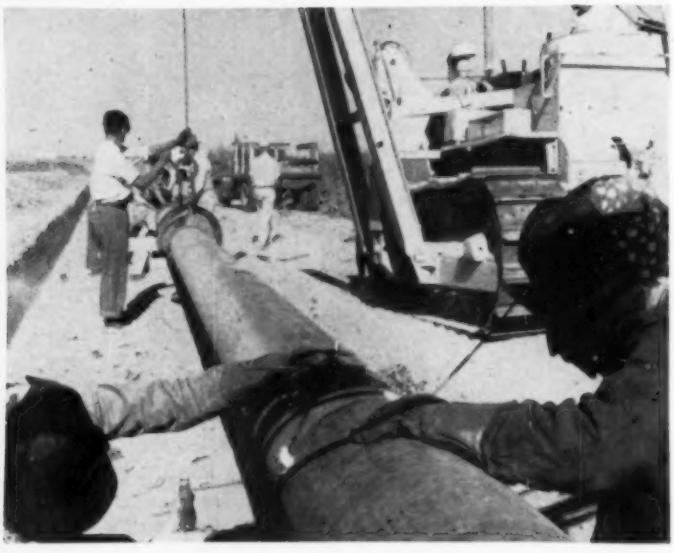
Beginning at Rota, the pipeline follows generally the valley of the Guadalquivir River, which is the principal drainage river of the Andalusian Plain. The terrain through this area is from flat to gently rolling hills with a maximum elevation of about 700 ft. This is one of the more fertile regions of Spain, and only about 15 miles from Rota is Jerez de la Frontera, the center of the region that produces the world famous "sherry."

In the vicinity of Cordoba, or pumping station No. 3 near Adamuz, the line crosses the various mountain ranges that make up the Sierra Morena chain. The maximum elevation of the line through this region is about 3000 ft, and it is in this area that rock excavation is necessary.

Northeast of pumping station No. 4 near Ciudad Real the line begins to cross the broad, arid central plain of Spain at an average elevation of about 2000 ft. Some 60 or 70 miles northeast of Madrid the terrain again becomes rugged. The line in this area reaches a maximum elevation of 4000 ft, and considerable rock excavation is necessary. The line then drops to a plateau just above the drainage plain of the historically famous Ebro River, and terminates near the old city of Zaragoza,



Unloading pipe at dockside.



With pipe joints held in alignment by line-up clamps, welders make the stringer bead.

whose name is derived from the Roman Caesar Augustus. Throughout the length of the pipeline, every effort has been made to avoid damage to the olive groves and vineyards of the Spaniards.

Practically all construction work in connection with the U. S. facilities in Spain is handled under a negotiated, fixed-fee contract between the Bureau of Yards and Docks and a group consisting of Brown and Root, Raymond Concrete Pile Company, and Walsh Construction Company (B-R-W). B-R-W, acting for and with the approval of the Navy's officer in charge of construction, solicits proposals and awards lump sum sub-contracts for component parts of the construction program to Spanish firms, or to combined Spanish-U. S. co-venturing companies, on a low bid basis.

Among the sub-contractors are Benson-Montin, Merritt, Chapman and Scott, and Argoman, pipe laying; Elder and McNulty, radiographic inspection of welds; Pittsburgh Des Moines Steel Company and Entrecaneles y Tavora, S.A., a part of the terminal storage tanks; Samford and Markowitz, construction of pumping stations and storage terminals.

In keeping with the spirit of the agreements, every effort is exerted to utilize materials, equipment, and manpower that is indigenous to Spain. It will be apparent, however, that in the matter of petroleum fuel storage, handling and transportation facilities, nearly all equipment and skilled specialists necessarily were imported from the United States. Practically all common and semi-skilled labor is Spanish, and Spanish artisans display some aptitude and early adeptness in skills such as construction equipment operation.

Design of System

Much of the basis for design of the line, and its component parts, is of a classified nature. Consequently, the data that follows may, at times, be incomplete insofar as would be necessary to give a complete picture.

The new harbor at Rota is designed to receive cargo from tankers and issue fuel to fleet units. In its receiving functions, the Navy fuel depot, Rota, can accept products for Navy storage and subsequently issue it to the nearby Naval air facility and to fleet units, or to Air Force storage, subsequently to be delivered to the pipeline for movement to inland bases. Products can be interchanged between Navy and Air Force storage to satisfy any emergency condition that may arise. The No. 1 pump station of the pipeline is situated near these storage facilities.

Design of the main line was based upon the use of seamless steel pipe conforming to the API Specification 5-L-X for a guaranteed yield point of 42,000 psi. The wall thickness of the pipe was based on an operating pressure that will produce a maximum unit stress in the pipe wall of not more than two-thirds the yield point, taking into consideration the mill tolerance of the pipe. A minimum wall thickness of 0.250 in. is specified. Steel tonnage in the main line is slightly more than 38,000 tons, including sleeves, casing, etc.

In the absence of electric power at the site of the pumping stations, all pumps are driven by diesel engines through speed increasers. Diesel-driven generators, however, provide auxiliary electric power at pumping stations and/or terminal.

Pumps are of uniform sizes in two capacity brackets. One size is utilized at pumping stations 1, 2, 3, and 4. In this bracket only the diameter of the impeller is adjusted to satisfy the flow rate characteristics for a particular pumping station. The second pump size, smaller than the first, is for pumping station No. 5 and future pumping station No. 6 for reverse flow from Zaragoza.

Basically, the pumping units in stations 1, 2, 3, and 4 are arranged for series operation. The units in pumping station No. 5 are arranged for parallel operation. Maximum flexibility in pumping rates is thus achieved with a minimum of spare parts for maintenance. Aside from three spare pumps, spare parts consist only of two or three rotors, impellers, mechanical seals, and the normal minor parts related thereto.

Diesel engine prime movers are 825 hp, achieved with a speed range of

Spanish workmen placing dynamite charges in rocky terrain.

Cleaning and priming the pipe prior to coating and wrapping.

from 700 to 900 rpm. They are designed to operate on either diesel or JP-4 fuel. JP-4 is a military grade of jet engine fuel having a Reid vapor pressure of 2-3 psi. Engines are required to conform to the standards of the Diesel Engine Manufacturers Association, and the rating of the engines is based upon the altitude and ambient atmospheric temperatures found in Spain. Maximum elevation can be about 3000 ft above sea level and the ambient air temperature can reach 105 F. Engines are skid-mounted and, including the spare engines, are easily transported and erected at any of the pumping stations.

Speed increasers between engine and pump are designed to transmit the maximum horsepower of the engine at input speeds of 700 to 900 rpm and outlet speeds of approximately 2800 to 3800 rpm.

Control of pumping units is quite conventional. Differential control of both suction and discharge pressure is utilized to actuate regulating valves and/or engine speed depending on the range of variation required. Except for station No. 1, each station can be bypassed and shutdown for low rates of flow.

Storage Terminals

Storage terminals are situated in the vicinity of pumping stations 1, 2, 4, 5, and Zaragoza. Basically, product may be taken from the main line and placed in storage for subsequent delivery by branch lines to Air Force bases in the area. As required to meet possible conditions of need, product can be taken from storage and delivered by pipeline to a terminal farther along the line.

All storage tanks are of the standard Navy cut-and-cover type. Vertical, steel, cylindrical tanks are constructed on, and anchored to, a reinforced concrete slab poured in the excavated area. A reinforced concrete slab is poured on the roof of the tank, after which earth cover is placed on top. This top concrete slab is designed to carry the weight of the earth cover, plus a live load, and transmit these forces by means of interior tank columns to the concrete foundation slab below. This type of construction yields a degree of blast resistance that, together with tank farm dispersion, protects the fuels from enemy action.

System Construction

Construction equipment and practices are largely similar to those employed in the United States. All major items of equipment were imported from the United States specifically for the project. Skilled craftsmen are primarily American, and several welders from England and Scotland are employed. All semi-skilled and common labor is recruited in the Spanish labor market.

Construction of the system as a whole has been subcontracted by the prime contractor, B-R-W, into several component phases. Pipe, engines, speed increasers, pumps, and diesel-driven generators were purchased directly by the prime contractor on the basis of competitive bidding, with factory inspection at the place of manufacture. These materials and equipment are worked into place by the appropriate sub-contractor. Sub-contracts, in all cases the low bidder coventures of U. S. and Spanish firms, have been awarded and are underway for the installation of the pipe, block valves, etc., construction of tankage, pumping stations, and terminals.

Line pipe is delivered to the sub-contractor at the ports of Cadiz and Valencia. The sub-contractor transports the pipe to the right-of-way and strings it. Clearing and grading crew consists of two or three tractors with angledozer attachments and 10 to 50 men, depending upon the nature of the terrain. In the mountainous sections, where rock is encountered, air compressors and jackhammers are used. Timber is rather sparse in Spain, consequently there are no timber crews.

Ditching is by means of a wheel type trencher that makes about two miles of ditch per day in other than rocky terrain. In rocky or mountainous areas two such machines are used. These machines also remove the overburden from underlying rock, which is removed by blasting. After removal of the rock, the trench is brought to grade by padding with earth. At one point in the mountains north of Cordoba more than 300 burros were used to transport earth to the right-of-way in baskets supported on each side of the animal.

In order to satisfy some of the Spanish requirements for installation of the pipeline, the following depths of cover were adopted:

In farming areas (Approx. 27.5 in.)	70 Cm.
In grazing areas (Approx. 22 in.)	56 Cm.
In rock areas (Approx. 11.8 in.)	30 Cm.

There were some instances where the cover for the line departed from these specifications; however, the depth of cover indicated above was the general practice.

Bending is accomplished with a side-

Backfilling the trench with bulldozer at low point in line where water has accumulated.

boom tractor equipped with a bending shoe attachment. Pipe is positioned with a sideboom tractor and the joint to be welded aligned with line-up clamps. Two welders, each using power from a heavy-duty 300-amp welder, apply the root bead; 200-amp machines are used by finishing welders. Rigid inspection of welds is practiced. All welds are visually inspected, and not less than 30 percent of all welds are X-rayed. A fully equipped field laboratory and dark room is available for this work.

External cleaning and priming of pipe is done in the usual manner. Sideboom tractors cradle the pipe during this operation, as well as the subsequent wrapping operation. Dope pots of 25-bbl capacity, equipped with mechanical agitators, supply enamel to the wrapping machine through a metallic hose. Coal tar saturated asbestos felt is used for wrapping over normal terrain.

In many rocky areas like this, dirt was brought in by mule pack to provide cover in order to protect coating.

Through rocky areas, an additional glass fiber wrap is provided as protection against abrasion. In addition to visual inspection, all coating is checked with a high voltage holiday detector to locate any points of improper dielectric strength.

Internal cleaning of the pipe is by sections averaging about 10 miles in length. A sizing scraper is run through the line, after which several sets of rubber cup and wire brush "pigs" are forced through the line by compressed air.

Except in rough terrain, the coated pipe is cradled directly into the ditch. During hot weather, sections are left supported on skids. These slack loops are lowered-in the following evening, and provide sufficient slack to prevent stresses in the pipe due to temperature changes. Wherever rock is encountered, padding of the trench is done by hand to insure proper protection of the coating.

Most road crossings are bored and casing installed for the line pipe. Occasionally a road is underlaid with rock, and conventional open cut methods are used.

Rivers in Spain are not much wider than minor streams in the United States. In all instances, except one, a backhoe, clamshell, or dragline was used to cut the trench across the streams. The complete pipe span, with weights and wood lagging, was lowered into the trench, then backfilled. The crossing of the Guadalquivir River, the longest river crossing, was made by "snaking" the completed, wood-lagged, weighted pipe across the stream. The pipe rests in the soft sandy bottom of the river.

Construction has been impeded since the start of work by a storm that on September 29, 1956, struck the ship containing the contractor's construction equipment, resulting in considerable damage, and by unusually heavy rains between November, 1955, and April, 1956.

The average progress in laying the 145 miles between Rota and Adamuz, was about 0.62 miles per day. In the mountainous regions north of Adamuz, progress averaged about 1 mile per day. In the gently rolling area, however, the rate of progress increased to about 3 miles per day. Consequently, the 10-in. line was installed at an average rate of about 1.56 miles per day. The 8-in. section between Madrid and Zaragoza is nearly complete and the average installation rate will be about 1.75 miles per day.

The line will be pressure tested to not more than 1.5 times nor less than 1.1 times the maximum working pressure of the system. This final hydraulic test will be made between successive block valves, using diesel fuel as the testing medium.

Control

Control of the system is centered in the dispatching headquarters at San Pablo. Leased lines are provided by the Spanish telephone system to all pumping stations and terminals for both voice and teletype use. Both fixed and mobile radio facilities are available for emergency use, or for mobile maintenance units. Remote control of pumping stations or terminals from the San Pablo headquarters is not provided, nor contemplated.

Each pumping station and terminal performs its functions on the basis of instructions received from dispatching headquarters. Liquid levels in terminal tanks are indicated in the respective pumping station headquarters, and are to be sent into dispatching headquarters at regular intervals.

Operation and Maintenance

Upon completion the system will be turned over to the Air Force. Operation and maintenance of the facilities will be under the direction of Air Force personnel, augmented by such local and U. S. civilian personnel as may be appropriate. It has been the aim of the Navy, during the design and construction stages of this project, to turn over to the Air Force a complete and usable system that would be a credit to a comparable products pipeline company in the United States, and one that will meet Air Force requirements in every way.

Acknowledgment

The writer wishes to express appreciation to Commander R. E. Sparks, CEC, USN, who, as resident officer in charge of construction for this products pipeline system, made available much of the current data and construction progress described herein. ★ ★

General view from pipe barge of the lay barge used in laying Interstate's 12-in. line into Lake Washington field. Nearest awning covers first welding station where the new joint of pipe is aligned and tacked to the completed line and the stringer bead is run. A filler (hot pass) weld is applied at the second covered station. The taller covered platform is manned when the barge is being pushed from under a completed section of pipe. Beyond the observation point is the third welding station where the cap weld is applied to the line. The finished weld is X-rayed and prime coated at the fourth station, not visible, and is finish coated at the fifth and final station, also not visible.

Construction Is Different In Marsh-Water Areas

W. R. Bilbo,
District Superintendent
Interstate Oil Pipe Line Company
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CRUDE oil pipe line construction in coastal Louisiana is far different from the conventional methods used over dry land in other parts of the country.

Some of the differences are technical ones of equipment and techniques. These are dictated by geographical conditions. Others, that are highly essential to pleasant and economic operations over a long period, stem from the traditions, means of livelihood, and background of the Acadian descendants who populate this area.

The technical differences come mainly under the heading of the right tools for the job, properly used. The others are a matter of human or public relations and boil down mainly to a full appreciation of and cooperation with the people of this area.

Coastal Louisiana is a unique area. Economically, fishing, oyster growing, and muskrat trapping are important sources of income for hundreds of families.

The oyster grower leases his lake bottom sites from the state. Seeding the beds is a costly process, and a well-established bed represents a substantial investment. Yet, there may be no surface indications of the presence of an oyster bed to help survey and construction crews avoid these important areas.

The trapper, on the other hand, does not want his valuable muskrat habitats disturbed because of the loss in rat production. In addition to this, land area may be lost through soil erosion due to current through floatation canals or other disturbances to the shore line.

In other words, this is an area in which the damages of pipe line construction cannot be repaired with a few passes of a bulldozer, some shovel work, and a little seeding and fertilizing as is the case in dry land pipe line construction.

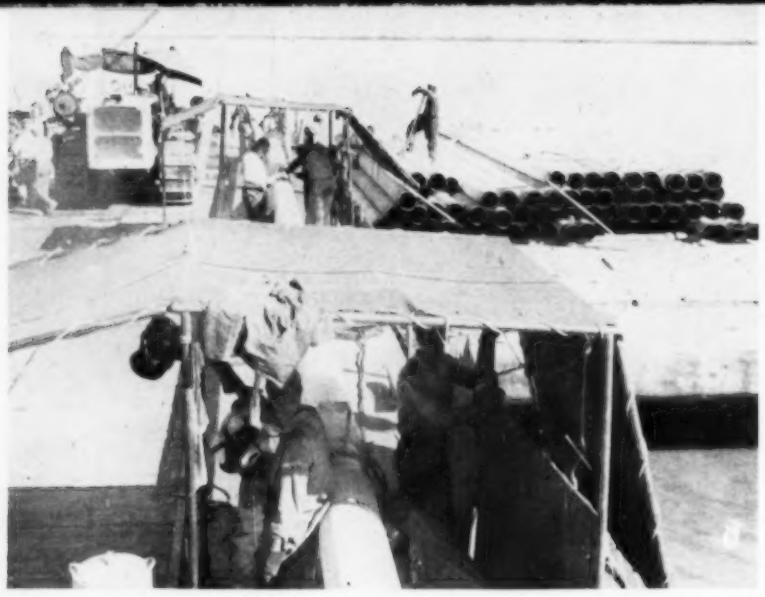
Interstate has been building and operating pipe lines in the Raceland District area since 1943 and in similar areas to the west since 1937. Experience has shown that the additional precautions necessary in designing and building a pipe line in this area, so as to result in a minimum of disturbance and damage to these traditional local industries, has been recovered many times in reduced damage claims and local good will.

Designing the Line

Designing and setting up specifications for an oil pipe line through marshland and water areas are little different from dry land practices. For small and medium size lines up to approximately 16 in. in diam the same wall thickness, same grade of pipe, same operating pressures, etc., as on dry land can be used. Coatings and cathodic protection specifications, however, should prescribe maximum protection against the highly corrosive conditions that exist in the salt marshes and brackish waters of the coastal area.

Routing the Right-of-Way

The initial survey crews and right-of-way agents are any pipe line company's first line of good will ambassadors. Interstate has found that the counsel of reliable and accepted local oyster men from the area to be traversed by the new line can be of immeasurable assistance not only during the initial phases of right-of-way acquisition but also through the construction period and the final clean-up.



This view, looking toward the first station from the observation platform, shows a new joint of pipe being tack welded onto the line. Sideboom tractor is used in picking up new joints of pipe and aligning them preparatory to welding. The filler weld is applied at the station nearest camera.

These men normally know the locations of most of the oyster beds, shrimping and fishing spots, and are usually acquainted with the muskrat trappers in the area. They are respected and accepted local citizens who speak the traditional French of the fisherman, oyster grower, and trapper. They can serve as the pipe line company's interpreters and contact men and render valuable public relations assistance.

Thorough reconnaissance is most important in selecting the route of a proposed marsh and water pipe line. Modern methods include the use of helicopters, small float planes, boats, marsh buggies, and other such equipment. Frequent conferences with the local oyster men, the U. S. Corps of Engineers, and the local fish and game conservation agents are highly desirable. The added expense of a few deviations from the straight-line route can often pay huge dividends in the form of reduced right-of-way and claims costs and increased good will.

Once the final route has been plotted actual surveying and right-of-way acquisition can get under way. In this area the absence of property lines and other topographic landmarks to which a survey tie can be made create a problem. It is often necessary to locate a government bench mark or geodetic survey station several miles away and calculate the survey party's position through precise triangulations.

The acquisition of rights-of-way across trapping lands and oyster bed waters is sometimes difficult and will require patience, understanding, and cooperation to the greatest degree in selecting the route least objectionable to the landowners and residents. Over state water bottoms and navigable waterways easements are not so difficult to obtain if the various rules of the appropriate regulatory bodies are complied with. This includes filing the proper information, such as route and profile maps, along with the written permission of the riparian owners with the initial right-of-way requests. Navigable waters are under the jurisdiction of the U. S. Corps of Engineers, and pipe lines constructed through such waters must meet strict requirements governing obstructions to navigation such as pipe depth, spoil disposal, identification and depth markers, etc., and permanent above-water structures such as pile-supported platforms for field pumping units.

Construction

Some of the main differences between marshland or water and dry land pipe line construction are found in transportation and ditching. Instead of the usual ditching machine, draglines are used to cut ditches across marshes and lake bottoms. On marshland the draglines are supported by heavy timber mats or by an amphibian crawler-type conveyance that is a variation of the marsh buggy. In open water the dragline is carried on a spud barge. Transportation of men, supplies, and equipment to and from the construction scene is a logistical matter of time, distance, and speed, that will vary from day to day and from location to location. It is safe to say, however, that travel to and from work, and transportation time of materials and equipment from receiving point to work location, are major items of the overall cost of the project.

For instance, the distances involved in marsh and water construction when coupled with the slowness of boat travel make travel time an important part of the work day. To this additional labor expense can be added the cost of time lost, but paid for, due to weather. A stiff breeze, which would be most welcome on a dry land job in summer, will cause waves that will halt operations on a water project. On a basis of past experience, it is estimated that one day out of ten is lost because of rough water.

The unit cost of any pipe line project usually decreases as the size of the project increases, and conversely increases as the size of the project decreases. This is especially true of water

A completed 12-in. line is being pushed through water-filled ditch through marshlands from a lay barge anchored at the marsh edge. This picture was taken during construction of Interstate's Lake Washington line.

and marshland jobs. The costly marine equipment required in such areas accounts for this to a large degree. Marine equipment is seldom available on short notice. It has to be assembled piece by piece and usually from several owners. Rental costs run high before work even gets under way. Some of it is idle a great part of the time but must be kept on hand or on standby status to be used as needed. For example, a small dragline on a spud barge and a tug costing $350 per day may not work more than two full days a week. Yet, if not available when needed, it could cause delays costing many times its weekly rental.

Similarly, because of the scarcity of equipment and the time involved in getting it to the work location, many spare pieces of equipment are included in the normal marine construction spread. The tables accompanying this article will give some idea of the operating and standby equipment requirements of a typical marsh-water pipe line construction spread. For an average 12-in. project, exclusive of ditching equipment, the equipment rentals for a typical marine construction spread will run in the neighborhood of $1500 per day. The cost of labor and supervision on the same spread will run approximately another $1500 per day.

Assembling the Line

Pipe lines in marshland and open water are customarily laid from a lay barge, which is actually a floating assembly line. The lay barge, usually 240 ft long and 30 ft wide, is assembled from two 30-ft by 120-ft spud-equipped barges fastened together with giant hinges. On the lay barge are five work stations positioned approximately 40 ft apart along the inclined laying and launching ramp. This arrangement makes it possible to carry on operations at all five stations at one time on an assembly line basis.

At the first position yard-coated pipe from the supply barge moored alongside the lay barge is picked up by a dragline or sideboom tractor, laid on the inclined ramp on the lay barge, aligned with the completed line, tacked, and the stringer bead run. The filler (hot pass) weld is applied at the second station. The crew at the third station applies the cap weld. At the fourth station the weld is X-rayed and the field point is primed. The field joint is coated at the fifth station, and the completed section is ready to be launched.

Prior to launching the completed line every inch is carefully inspected with a holiday detector, and all welds are X-ray tested. Inspection is even more important on a water or marsh line than on dry land because of the time and expense of bringing men and equipment back to the site to correct defects discovered during hydrostatic and air tests after the line has been launched.

The No. 1 station of a high ground push location used during construction of Interstate's Little Lake-Larose 16-in. line. Note the track-type rollers used to support the grounded end of the line and to permit the line to be pushed out into a water-filled ditch as new joints are added.

Launching Water Jobs

On water jobs launching the completed section of line is accomplished by moving the lay barge out from under the newly completed line and allowing the pipe to come to rest in the ditch. When all is in readiness for the move, the spuds are raised and the pulling machine cable is attached to a cap placed over the end of the last joint of pipe added to the line. Spooling-in the cable applies pressure to the end of the anchored pipe line, causing the lay barge to move along the ditch. The pipe moving across the lay barge is supported by rollers on the ramp. Movement is continued until the end of the string reaches No. 1 station, approximately 40 ft, when the pulling machine is stopped and the barge spuds lowered to anchor the lay barge in position for the next operation.

This construction technique was used on two Interstate projects in coastal Louisiana in 1955. On a 16-in. line into Little Lake field the contractor averaged ½ mile per day across 3.3 miles of Little Lake. On 9.6 miles of 12-in. line across Barataria Bay the contractor averaged 1800 ft per day with tie-ins and underwater crossings excluded.

Sinking the Line

Large diameter crude oil pipe lines with wall thicknesses of ¼ in. to ⅜ in. and not weight-coated will float unless kept filled with fluid when laid in marsh and water areas. Although this is advantageous on marsh and swamp jobs where the completed line is pushed through the ditch from a stationary assembly point, it is a definite disadvantage on an open water job.

The starting end of the water section must be carefully prepared to receive clean water in sufficient quantity to fill the line and to keep it filled as additional pipe is added to the section. Failure to keep the line filled with fluid will allow the pipe to float high in the ditch or completely out of it. When this happens construction must be stopped while the necessary digging equipment is towed back to the site to correct the condition.

Launching Marsh Jobs

On marsh jobs the assembly line may be on a lay barge anchored at the end of the ditch, or on a patch of high ground. The principal difference in construction procedure is that the assembly line remains stationary while the completed line is pushed through the previously-prepared ditch, which is filled with water. The end of the string of pipe entering the water is capped before launching so that the completed line will float along the ditch as new joints of pipe are added and the completed string is pushed, joint by joint, away from the assembly point.

Pushing is accomplished either by a tractor traveling alongside the moving string or by a pulling machine cable attached to the end of the pipe line. When the entire section has been completed and pushed into place, it is allowed to fill with water and sink to the bottom of the ditch.

During construction of Interstate's 16-in. line to Little Lake field, 10 miles of line were laid and pushed into a 4-ft by 4-ft marsh ditch in one continuing operation from a push ramp situated on the bank of the Intracoastal Canal near Larose, Louisiana. On this part of the job the contractor averaged a mile a day.

P 615.6

Marshland ditching scene here shows the amphibian crawler-type dragline. It is self-propelled and is a variation of the marsh buggy.

Marshland ditching scene shows two swamp buggies towing a small dragline that has been mounted on pontoons for swamp duty.

Gathering System Construction

Many of the trunk line construction techniques described above are also used in building gathering systems in water and marshland areas, although usually on a smaller scale because of the smaller and shorter lines involved in gathering operations. Construction costs are not reduced, however, in proportion because the cost of assembling the spread and moving it in to the job and out again is spread over a much shorter period.

Field Pumping Units

Field pumping units are much more costly to install in marshland or water areas than on dry land, one of the major differences being in the cost of suitable foundations. These pumping units are customarily set on pile-supported platforms, which cost approximately $8 per sq ft in a marsh area and up to $10 per sq ft for the higher and stronger platforms used in open water.

A 5 x 10 gas engine-driven pump with attendant accessories, control valves, and piping requires an 18-ft by 24-ft platform. A two-unit station will require a 30-ft by 24-ft platform.

Because it is desirable from an investment and operating cost standpoint to locate gathering pumps as nearly central to as many existing and possible future tank batteries as feasible, a great deal of study and speculation on future prospects goes into the selection of a field station site.

Producers' tank batteries usually are constructed on piling platforms well above the marsh or water level, thus providing a good suction head and making long suction lines practicable. In Interstate's Little Lake field system 8-in. suction lines 8500 ft long provided sufficient volume to fill two 4 by 10 pumps.

In laying out the field pump station, piping and control valves are located on the platform floor to be readily accessible to the gager. Pumps and engines are set in steel pans with 3-in. sidewalls for possible oil drips. The pans are connected by gravity line to a steel sump tank, which in turn is connected to the pump suction. This arrangement serves three purposes: (1) Improves housekeeping, (2) helps eliminate fire hazards, and (3) complies with fish and wildlife regulations governing pollution.

Pumping unit maintenance costs in water areas are very high due to personnel and material transportation expenses. A mechanic may have to spend two hours in a $5 per hour boat getting to and from a unit to make a minor repair or adjustment. The damp, salty atmosphere in such areas causes considerable corrosion of ignition and electrical controls. Keeping the entire unit, including oil piping and valves, free from rust requires close inspection and careful maintenance.

Interstate's pumping units are equipped to operate with a minimum of operator attention. Exhaust condensers keep radiators filled; oil level regulators maintain proper crankcase lube oil levels; scrubbers keep the gas fuel free of moisture; automatic shut-down devices stop the engines if lubricating or cooling systems fail; a predetermined high or low line pressure will also stop the engines. Time clocks are used to shut down the units at predetermined times.

Conclusion

It should be apparent from the above information that it is imperative in water and marsh areas to build as good a pipe line as humanly possible. The high costs of construction, maintenance and repair make anything but a first-class line almost prohibitive to keep in operation over a long range period.

Basically, there are four governing factors for a good marsh pipe line: (1) Design (including specifications) (2) first quality materials, (3) a reliable and experienced contractor, and (4) competent company inspection during construction.

Of these, the company inspection is the most important. Without capable and conscientious inspection, the best that the industry has to offer in design, materials, and contractors may not guarantee a good line.

Table 1. TYPICAL EQUIPMENT IN A MARSH-WATER SPREAD

1 lay barge (30 ft by 240 ft) with cable lift spuds	1 pulling machine
1 small spud barge	7 welding machines
3 pipe barges	1 electric power plant
2 75-100 hp tugs with crews	1 large dope pot
2 crew boats with operators	1 small dope pot
1 ¾-yard dragline with operator	1 X-ray outfit
1 large side boom tractor	1 holiday detector
	1 pipe beveling machine
	1 oxygen and acetylene rig
	Miscellaneous hand tools

Table 2. TYPICAL PERSONNEL ON MARSH-WATER SPREAD

1 spread foreman	1 pipe stabber
1 pipe foreman	1 clamp man
1 welder foreman	6 welder helpers
1 dope foreman	1 tractor driver
1 dope pot foreman	1 tractor driver swamper
1 ditch foreman	2 pulling machine operators
2 pipe spacers or line-up men	1 mechanic
7 welders	15 laborers

Table 3. PERSONNEL AND EQUIPMENT FOR MARSH DITCHING

2 ¾-yard draglines on mats for firm marsh and swamp areas with operator and helper on each machine. (Each machine can ditch approximately 500 ft in 12 hr.)
1 ½-yard marsh ditcher for bad marsh areas (small dragline mounted on marsh buggy type crawler tracks) with operator and helper.
2 small crew boats, with skipper for each.

Table 4. PERSONNEL AND EQUIPMENT FOR WATER DITCHING

2 3-yard draglines on spud barges, with living quarters for 24-hr crew.

1 crew boat	2 helpers
1 dredge captain	1 cook
2 operators	1 boat skipper

Landis Lee, delivery man, remotely gages tanks at American Oil Pipe Line Company's Colorado City station.

In Lonesome West Texas

PUSHBUTTONS TAKE OVER BOOSTER STATION OPERATION

Howard Bell*

AMERICAN Oil Pipe Line Company* has a successful operation in West Texas wherein two intermediate stations are being controlled remotely from a mainline station. The latter is at Colorado City. The controlled stations are the Sterling booster, 40 miles to the south, and Irion station, 40 miles still farther south, the latter injecting into the trunkline. Control is by means of microwave.

Colorado station is the origin station on the trunkline that extends 125 miles to a terminal on the Rancho System at El Dorado, Texas. The line is a combination 10 and 16-in.

Sterling station was designed from the outset for eventual unattended remote control over the microwave system that was completed in September, 1950. At that time, the trunkline terminated at Humble Arden junction. Sterling station was placed in service as an attended pushbutton booster in June, 1951. In early 1955, the 16-in. line had been completed to Rancho, and Irion station, receiving crude from Cope field, was completed and placed in service. In the meantime, Sterling had become the injection point for crudes from the Jameson field, and 80,000-bbl and 10,000-bbl tanks with a manually controlled booster pump for feeding the main units had been installed.

The original remote control equipment for Sterling was modified in order that Irion and Sterling both could be controlled from Colorado City.

Supervisory Control

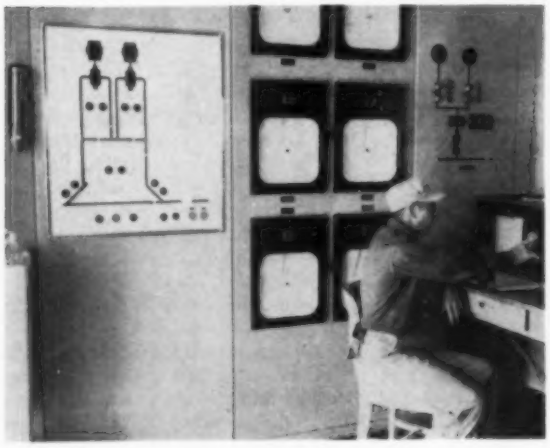
The microwave system has one voice channel devoted to supervisory control and telemetering. Subdivision of this channel by audio tone generators of different frequency provides for each telemetered function and supervision and control of both Irion and Sterling.

Supervisory relay selection is by coded impulse interruption of tones. Point selection and operator codes are transmitted by a single operation, simulating the normal control at a pushbutton station.

Whenever it is desired to start a unit at Sterling, the operator at Colorado City momentarily presses the start pushbutton for the unit selected. A

*Formerly with American Oil Pipe Line Company, now with Pipe Line Technologists, Inc., Houston, Texas.

Since this article was written American Oil Pipe Line Company has become a part of Service Pipe Line Company.



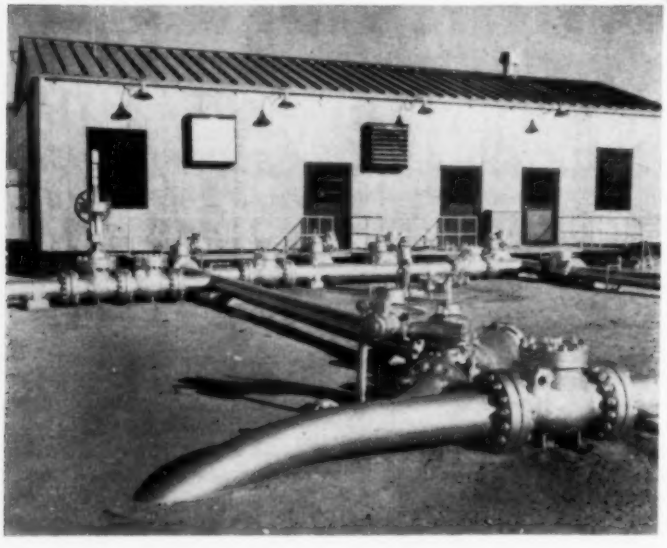
"Parent" station at Colorado City (above) can control satellite station at Sterling City. Microwave tower at right transmits telemetering and control signals.

U. B. Blackshear at Colorado City station (left) at the controls that can start, stop, and take pressures at the Sterling City station some 40 miles away. Panel at left is schematic of the Sterling City station.

Satellite station at Sterling City. The radio tower at right is FM. Only the dish in the foreground receives and transmits signals from nearby microwave tower spotted on a hill 250 ft high.

Close up of receiver at the Sterling City station, which is forecast on the tower situated on a hill a mile or so away.

Manifold outside of Sterling City station. The valves are automatically controlled.



coded impulse is transmitted to Sterling where the point is selected and a check code transmitted back to Colorado City. A white light momentarily lights at Colorado City verifying the point selection. If the codes do not agree, the equipment resets. When the codes check, the Colorado City equipment automatically transmits an operation code to Sterling, which begins the starting sequence. A code is transmitted back to Colorado City, which lights both MO valve position lights at Colorado City indicating the starting sequence has begun. When the unit is on the line, another code from Sterling results in the correct position light remaining on. The Colorado City equipment then transmits a reset code, which returns equipment at both locations to "at rest." A master check pushbutton is provided that will check the positions of all indicating lamps in sequence.

Continuous telemetering of pressure and amperage is of the pulse duration type. Selective telemetering of the tank gage at Irion is performed by a pulse-code system.

Irion Station Design

The remote control of Irion station includes the following: (1) Sequence starting; (2) valve, pump motor, and lockout supervision, and (3) tank gage and pressure telemetering.

A 5000-bbl tank is continually open to the line from Cope field, with a back pressure valve for shutoff control. The gager in Cope field pumps into the tank only during the day, allowing for remote injection at night without floating the tank. The injection pump is a 7 in. by 10 in. reciprocating unit belt driven by a 75-hp, 1200-rpm, TEFC motor. The discharge of the pump is always open to the mainline with a check valve for shutoff. The suction of the pump is connected to the 5000-bbl tank by a 40-second motor operated valve.

A motor-spring operated bypass valve is installed. Colorado City starts the unit by pressing the start pushbutton. The transmitted code opens the suction valve. When the suction valve reaches the fully open position, a limit switch begins opening the bypass.

When the bypass reaches the fully open position, the pump is started. A contact on the motor starter begins the bypass closure, which is completed in 100 seconds. The unit is on the line at full pressure in 240 seconds (4 min). A time delay sequence check relay will trip the unit off if the motor is not started, with suction valve open, bypass closed, and proper suction and discharge pressures established within 240 seconds.

When the unit is stopped, bypass remains closed, the motor stops and the suction valve begins closing simultaneously.

A foreign 5000-bbl tank is connected to the suction of the pump also by means of a manually operated valve with limit switch interlocks. The position of the valve is supervised remotely and the pump may be started and stopped so as to remotely control the pump out of this tank, provided the valve is manually opened.

The protective devices that shut down the station are high discharge, low discharge, and low suction pressure. The station is locked out by motor overload or by either excessive gland leakage into the sump or a high sump. Upon the occurance of any of these,

the operator at Colorado City will get an alarm and flashing red light indicating motor shutdown; if the unit is locked out, then he will get a flashing red lockout light. He will also get an alarm when the tank is either high or low with automatic gaging at one minute intervals until the tank is within limits.

Local control also is provided. In addition, the sump may be pumped out with the pump by means of a momentary contact switch that bridges the low suction, low discharge, and time delay contacts.

Pressure of the passing line is continuously telemetered. Whenever the unit starts, the pressure pickup is transferred by means of a solenoid valve to the pump side of the discharge gate and check valves.

The remote tank gage receiver at Colorado City is for a multi-tank system. At present, the Irion tank is the only tank with a transmitter installed. The operator dials the tank he wishes to gage. The transmitter at the tank then sends out a dot-dash code indicating the gage to ⅛ in. The gage remains on the receiver for 45 seconds.

All equipment at Irion is installed outdoors. An 8-ft by 10-ft building is provided for storage, telephone, and shelter for visiting firemen.

Sterling Station Design

The two main units and control equipment at Sterling is housed in a single metal building with a firewall separating the open type switch gear from the explosion-proof equipment in the pump room. A fan in the control room provides for constant pressuring. Each of the two main units has a two-speed exhaust fan in the wall opposite the pump.

The pumps are three-stage horizontal centrifugals rated at 52,000 bbl per day at 450 psi each. They are driven by 500-hp, TEFC, 3600-rpm, 2300-v motors. Standby 125-v nickel-cadium batteries for the control equipment are located in the control room. A 3-kw emergency motor generator set is located in a separate building.

Lubricated motor-operated plug valves are used in the aboveground manifolding. A 4-min motor operated line block valve also is installed at Sterling.

The station suction and discharge valves have 60-second motors. Each of these three valves has individual remote control and supervision. Each pump unit has a 60-second suction valve and 90-second discharge valve operated in sequence by individual unit control and supervision. The main circuit breaker is also individually controlled and supervised.

The sump is drained by an automatic float controlled pump discharging into tankage.

Station suction, intermediate and discharge pressures, as well as one phase current on each unit, are telemetered continuously.

An alarm only will be sounded at Colorado City for: Low battery voltage, high motor winding temperature, high sump level, or control room fan stoppage.

Individual unit shutdowns and alarm without lockout occurs on undervoltage, motor overload, sequence failure, low suction, high case or high discharge pressure, or exhaust fan stoppage.

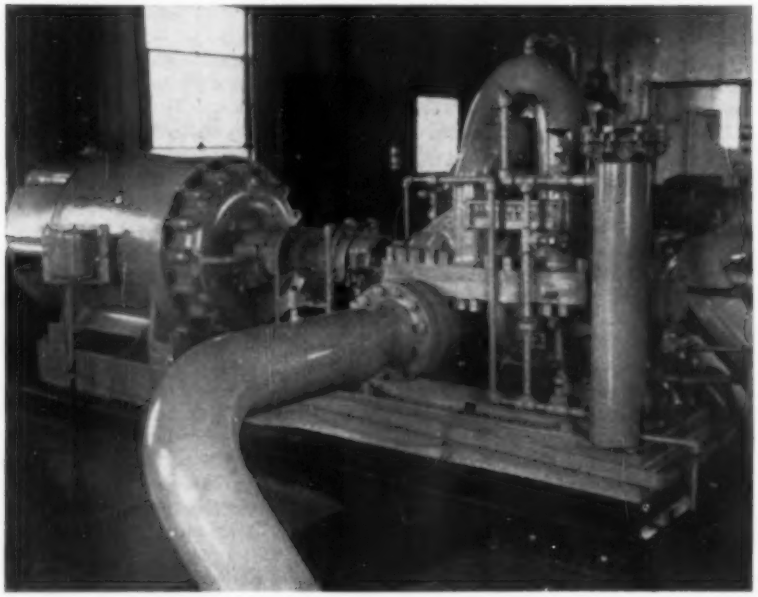
A time delay is provided on pressure devices to prevent momentary surges from shutting the station down.

Individual unit lockouts occur on overcurrent, high pump case temperature, high motor or pump bearing temperature, or excessive seal leakage.

The main unit circuit breaker is tripped on phase reversal, and tripped and locked out on phase unbalance or station overcurrent.

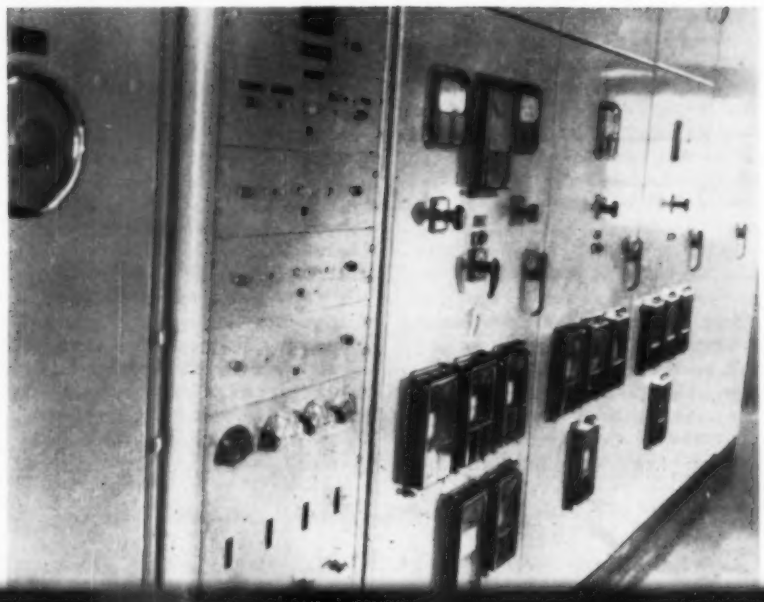
Both units will be shut down and locked out by tripping of their individual breakers whenever the gas concentration in the pump room rises to 25 per cent of the lower explosive limit. The gas detection unit is in the control room with a pickup head in the vicinity of each pump seal.

The Colorado City panel indicates alarms, shutdowns, and lockouts by



Inside the Sterling City pump room.

Control panel at Sterling City.



groups rather than individually. In the event a malfunction occurs in any group, the red light for that group flashes and an alarm sounds. The operator may silence the alarm and reset the flashing light to a steady light. When the condition is cleared, the alarm again sounds and the green light flashes. The groups are:

Pressure — all shutdown only.

Mechanical — all lockout.

Electrical — two alarms, one shutdown, two lockouts.

Power supply — two shutdown, one lockout.

Gas detector — lockout.

High sump — alarm.

Auxiliaries — one shutdown, one alarm.

The panel also indicates whether the control switch at Sterling station has been turned from remote to local control and whether the channels to Sterling and Irion are in operation.

Both seal sumps on each pump are drained into a combination float chamber and switch. The outlet of the float chamber is alternately opened and closed by means of a solenoid valve. The time the valve is open and closed determines the rate of leakage that can be detected. Two adjustable timers are employed to control the valve.

Automatic venting of the pumps on startup is accomplished by means of a solenoid pilot-operated valve on each pump.

The station does not have a discharge control valve for the following reasons:

1. The crudes handled through the station are essentially of the same viscosity, but in any event control is provided by the fact that Colorado City station immediately upstream has three engine-driven units with speed control.

2. No trouble has been experienced when pumping from tankage at Sterling with the fixed head booster pump, although such an operation was not contemplated in the original design.

Furthermore, the use of air for control was studiously avoided and in 1950, a control valve necessarily would have been air operated.

Before either of the main units can be started, the line block valve must be open, as well as the station discharge valve and either the station suction valve or a tank suction valve. The starting sequence is that the unit suction valve first opens, the unit exhaust fan starts, and the vent valve opens. The pump motor is then started, which is followed by opening of the discharge valve. Closure of the vent valve occurs when the discharge valve is fully open.

If any of the station valves leave the fully open position, both units shut down. If either the suction or discharge valve of a running unit leaves the fully open position, that unit shuts down. A unit shutdown is accompanied by closure of its suction and discharge valve and stoppage of the exhaust fan.

A sequence checking relay will shut the unit down, if after 60 seconds, the suction valve is not fully open, the fan started, and the vent valve opened. If after 160 seconds the complete starting sequence has not been completed, this relay will also shut the unit down.

No provision is made for starting Sterling station without suction pressure being established.

Sterling Station Booster Design

The development of Jameson field resulted in the erection of initially a 10,000-bbl tank and later an 80,000-bbl floating roof tank at Sterling. A vertical centrifugal booster has been installed capable of feeding both units at full head with a suction pressure of 120 psi. The pump is driven by a 125 hp vertical TEFC, 2300-v motor.

At present, this pump is operated manually, but remote control will be provided. The suction valve from each tank will be individually controlled and supervised. The pump discharge valve will operate in sequence with the pump, being partially open when the pump starts. Shutdown from abnormal causes will be supervised as to lockout or shutdown without lockout. High pump case temperature, or low suction pressure, will shut the pump down. Excessive vibration, excessive seal leakage, motor overload, or high motor winding temperature will shut down and lock out the pump.

Pulse code transmitters will be installed on both tanks at Sterling so that they may be gaged on the receiver now installed at Colorado City station.

Operational Experience

There have been the normal amount of bugs and oversights in both stations. Some of these could be expected in any type of new installation. At Irion, it was necessary to repack the bypass valve twice and remount the low suction pressure mercoid at a lower elevation because of erratic behavior. This mercoid could be and was overpressured as originally piped. An overpressure safety device was added. It was necessary to redesign the pressure piping to safety devices to prevent plugging.

A source of trouble at Sterling was lubricating of the plug valves. The limit switches on the motor operators must be very closely set or the valve lubrication channels will be exposed to washing when the valve is not fully opened or closed. A regular lubrication schedule must be maintained. It was sometime before the problem of sticking valves was licked. Some difficulty was experienced with the low suction mercoids at Sterling either because of plugged pressure lines or a defective overpressure diaphragm.

The gas analyzer has not been entirely satisfactory. The timing clock froze, relays stuck, the sampling lines became plugged, and filaments burned out rapidly. These problems have now been solved satisfactorily. The gas detector originally opened the main circuit breaker. After rewiring, the main breaker now remains closed in order to close all valves.

The dust conditions in West Texas have resulted in some trouble with regard to keeping properly cleaned for satisfactory operation. All the above are troubles that would be experienced if the stations were locally pushbutton controlled.

The main concern has been the communication path and the equipment for translating the signal to this path. Irion station, shortly after installation, developed a habit of doing its own thinking. The operator at Colorado City discovered it on the line, or evidence of its having been on the line, without any action on his part. After ruling out outside persons, relays were installed to prevent any false operations from extraneous noise or diminution of the S/N ratio.

A single telemetering or supervisory control circuit may be lost without affecting other circuits. In the event of failure of the complete channel, the stations will continue to operate subject to local protective device shutdown.

Over a period of time, communication equipment has been sealed from dust, insulated against heat, automatic exercising equipment for emergency power units has been installed, and preventive maintenance techniques developed.

Until the booster pump and tank valves at Sterling are placed on remote control, this station will continue to be manned. At that time, that station will be unattended with the exception of the presence of an area supervisor in a cottage at the station site. Irion has been completely unattended except for a two week shakedown period.

Design Changes Suggested

There have been many remote stations designed since 1950, and several new equipment developments. It is gratifying that most of the new stations follow, in the main, the same pattern as Sterling station.

During the changeover to remote

operation of the booster pump at Sterling, it is likely that a master check function will be added to the supervisory control equipment for Irion such as is provided at Sterling. The grouping of Sterling malfunction indications back to Colorado City may be changed so as to always be able to distinguish between a shutdown and lockout and possible determination of conditions causing an alarm. Thinking has changed somewhat on what should be an alarm, shutdown, or lockout. There have been some inconsistencies along these lines between the two stations and the booster pump.

The advent of electrical pressure instrumentations and electric control valves make the use of an instrument air system and its disadvantages obsolete for remote stations in the writer's opinion. Better gas detection equipment is now available although the trend is to outdoor installations in which gas detection is not so important.

Separation of pumps and control equipment is favored, and the use of weatherprotected outdoor motors under a flat roof with no sides to allow complete ventilation without the use of fans. There is some question on the use of open motors in the dust of West Texas.

Above-ground manifolds are attractive, but present expansion and anchoring problems.

The grouping of shutdown devices and piping pressure to them with small lines should be avoided by placing the primary device at the source of measurement.

Although we have not used any as yet, I believe a vibration detection device is a valuable addition to the protective features in a station.

It is a temptation to go overboard on the control and supervisory points by trying to duplicate an attended station condition. Considerable attention should be given to the necessity of each telemetered function and control and supervision function. Sequencing and interlocks with one control point can be quite effective. On the other hand, extensive use of protective devices is warranted. Some of these devices now found only in unattended stations could well be used in attended stations. The devices should be the best obtainable and thoroughly tested against erratic behavior. Whenever possible, relays should be sealed and left sealed except for scheduled checks.

The choice of a communications link should be made on the basis of economics and requirements. Adequate reliability of remote control is attainable for any link now in service. Microwave should have less outages than physical links under extremes of climate and weather. ★ ★ ★

Canadian News Notes

Interprovincial loop. Interprovincial Pipe Line Company has awarded construction contracts for the first two jobs on its 1957 expansion agenda. Fulton Banister, Ltd., has the contract for 32.6 miles of 24-in. loop of the Saskatchewan section of the main line, between a point near Kendal and a point near Peebles, in the southeastern sector. The expected start date is June 1, with completion hoped for by the end of July. Jerry Nash will be in general charge of construction.

Completion of this loop will provide Interprovincial with the equivalent of two complete lines between Edmonton and Gretna, Manitoba, where the line crosses the border into Minnesota. A second contract, between Gretna and Superior, Wisconsin, has been awarded to R. H. Fulton & Company, Lubbock, Texas, for 78.4 miles of 26-in. loop, filling in the remaining gaps in the 26-in. loop of the Minnesota section of the line. This will provide 20-in. and 26-in. parallel lines across Minnesota.

Trans Mountain. The pumping station fire at Gainford, Alberta, on the Trans Mountain crude oil pipeline, resulted in loss of about 20,000 bbl per day in December traffic. Refiners on the line had nominated for about 178,000 bbl, but the loss of capacity pending repairs reduced the estimated December throughput to 155,000 bbl per day.

Long-range plans visualize ultimate increase to 300,000 bbl per day within the next three years. This will be done by laying a 30-in. loop on part of the existing 24-in. system, instead of increasing pumping stations to full capacity as originally contemplated. Station construction will go ahead this year to raise capacity of the 24-in. line to 240,000 bbl per day by the end of the summer. Pipe for the loop will be available before 1958, according to Trans Mountain officials. This will, however, coincide approximately with the expected completion of the Standard Oil Company of California refinery to be built on Puget Sound, starting about the end of 1957. Traffic for the current year is calculated at approximately 175,000 bbl per day average.

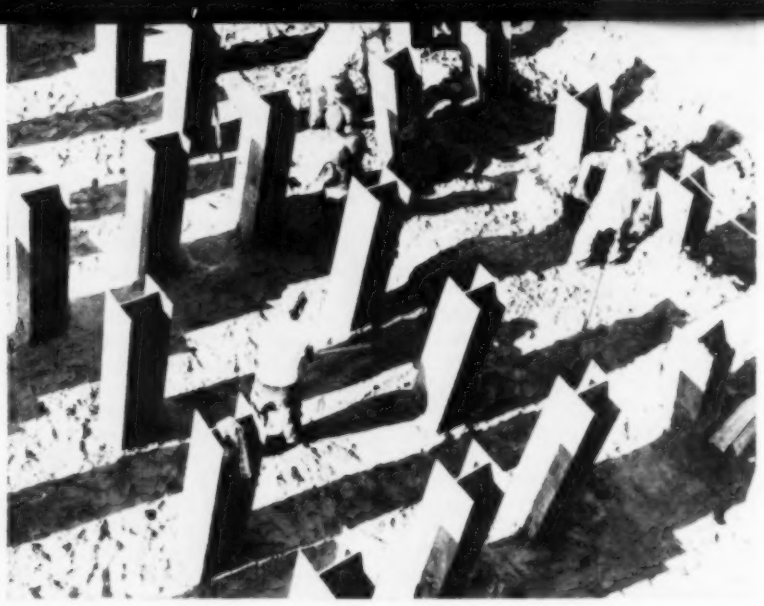
Westcoast. A phenomenal construction job was done by Dutton-Williams Brothers, Ltd., on the 30-in. natural gas pipeline of Westcoast Transmission Company, northern section. The contractor completed the entire section on December 15, nine months ahead of schedule and in less than 12 months' working time from the commencement of right-of-way clearing. Thelmer Davis was the spread superintendent responsible for the speedy completion of the 120-mile section, which contained difficult muskeg terrain and the ascent of Pine Pass, the backbone of the Canadian Rocky Mountains.

On the entire 649-mile line, 455 miles were in the ground by the time construction shut down for the winter. Deliveries are to start in October, and Westcoast has just announced a major increase in prospective markets, requiring a raise from 400 to 660 MMcf per day in capacity of the system. This will involve immediate plans for an increase in compressor stations, but it is not expected that any substantial looping will have to be done. The bulk of the demand is in the Pacific Northwest states, where Westcoast will deliver Canadian gas to the El Paso-Pacific Northwest system.

Trans-Canada. Work is scheduled to begin by February 1, if weather is favorable, on clearing and grading right-of-way for section 7 of Trans-Canada Pipe Lines, Ltd., natural gas pipeline east of Winnipeg. This 30-in. line is projected for eventual completion to the head of Lake Superior, possibly by the end of the 1957 construction season.

The contract has been awarded to Majestic Contractors, Ltd., with R. L. (Dick) Leonard as spread superintendent. An office and warehouse have been opened in Ste. Anne des Chenes, 25 miles east of Winnipeg, for the first portion of the job, which consists of approximately 85 miles, largely through muskeg and solid igneous rock. The rock ditch is said to involve problems never before experienced in any rock country, as even West Virginia rock is stratified to some extent, whereas the eastern Manitoba granite is absolutely homogeneous. Shot holes will have to be diamond drilled for dynamiting.

Pipe for this section will not be delivered before spring, as it is coming from the new Welland Tubes, Ltd., mill, which will not be able to start rolling it until about April or May. The projected starting date for actual pipe laying is not until June, but it is likely that some rock ditching will start through the winter as no caving can occur with this type of ditch.



Sixty-eight 14-in. "H" piles of 73 lb per ft were driven to a minimum bearing of 50 tons each for the Iowa main anchorage.

Northern's largest suspension bridge carries two 30-in. gas lines over the Missouri River at Plattsmouth, Nebraska.

Two aerial lines join three underwater crossings to provide versatility at critical point on Northern Natural Gas Company's pipe line system

P 623.381

Across the wide Missouri . . .

Twin 30-In. Lines Span River Via Super Suspension Bridge

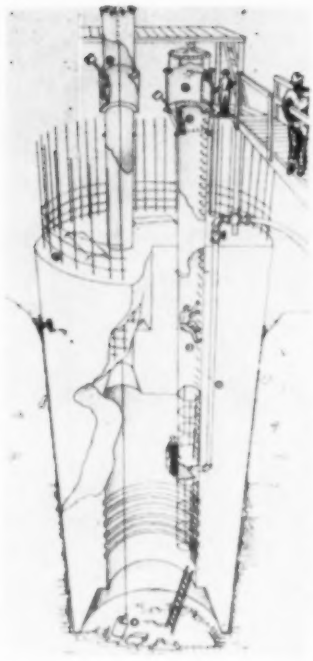
C. A. Reynolds
Senior Engineer, Northern Natural Gas Company

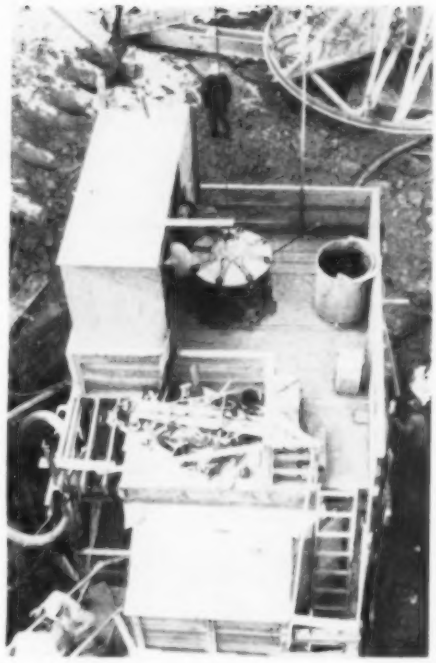
NOW in operation is Northern Natural Gas Company's largest pipe line suspension bridge over the Missouri River south of Plattsmouth, Nebraska. The bridge carries two 30-in. natural gas pipe lines across a critical point in Northern's 10,000-mile system.

Northern's expansion program to increase daily capacity from 825,000,000 cu ft to 1,100,000,000 cu ft over a two-year period (1953-54) was authorized in May, 1953 by the FPC. Plans were to increase to 1,007,000,000 cu ft in 1953 and to 1,100,000,000 cu ft in 1954. The 1954 program included 16.5 miles of 30-in. loop line from northeast of Northern's 30,000-hp Palmyra, Nebraska, compressor station to the Missouri River and extending on the Iowa side towards the Oakland, Iowa, compressor station.

With nearly 60 per cent of daily capacity crossing the Missouri at this point, Northern was faced with the problem in 1954 of increasing capacity there and allowing for greater increases in the future to meet an expanding market. In 1954, Northern had a 24-in., 26-in., and the new 30-in. line from its Palmyra station to the Missouri River. The 24-in. line crossed on the Plattsmouth auto bridge while the 26 and 30-in. lines crossed under the river in two 20-in. lines.

Consideration was given by Northern engineers to the best means of crossing, and studies that dated back to 1946 showed the terrain suitable for a suspension bridge whereas no suitable undercrossing site was discovered. The decision made, Matthews and Kenan, Engineers, of San Antonio, Texas, were asked to design a pipe line suspension bridge to carry two 30-in.





Caisson details: (1) man lock, (2) pressure door, (3) man shaft ladder, (4) muck bucket, (5) material lock, (6) service line, (7) concrete and reinforcing rods. (Right) View of one of the caissons. The material lock is seen at top center and the man lock at lower center.

OD by ½-in. wall thickness lines side by side.

Submitted to the engineering company were Northern's topographical studies and profiles in addition to the results of the test drilling by the Omaha Drilling Corporation. Test holes were drilled through the overburden to bed rock at the proposed site of each load bearing structure. More than 20 test holes were drilled and drilling logs maintained from core samples.

Due to the different topography on each side of the river the bridge designed by Matthews and Kenan was not symmetrical but designed to meet the problems of topography encountered on the Iowa and Nebraska sides.

General Description

The distance between the two main towers is 1500 ft. On the Iowa side, an additional side span of 750 ft carries the pipe line over flood levees and a rest pier stands at the eastern end of the span. One anchor block serves both main cables and wind cables.

On the Nebraska side a 154-ft truss span extends from the main tower to the top of the steep bank on this side. Topography made it necessary to construct the wind cable anchor blocks 253 ft from the main tower and two main cable anchor blocks 670 ft from the Nebraska main tower. This results in the total pipe carrying length of the bridge of 2404 ft and a distance of 3331 ft between main anchor blocks.

Awarded the contract for construction was Pittsburgh-Des Moines Steel Company, Dallas, Texas. L. H. Heidbreder was named their superintendent for the project. Construction began in June, 1954, with E. A. Trabold as Northern's resident engineer.

Anchor Blocks

First job to kick off was driving of pile for the main anchor block on the Iowa side where 68 14-in. piles of 73 lb per ft were driven to a minimum bearing of 50 tons each. A total of 4758 ft of piling was driven for this block. The minimum bearing was established by the "New Engineering Formula."

Concrete for this main anchor block was poured in two sections. The first section was poured mainly below grade with a stair-step arrangement at the back of the anchorage. Second section to be poured interlocked and contained the anchor bolts in one grillage.

The main cable bolts were 3¾-in., hot rolled AISI C1045, normalized steel bolts. Wind cable bolts were 3½-in., with same specifications. A total of 1376 cu yd of concrete and 25,431 lb of reinforcing steel were used in the Iowa main anchorage.

As mentioned before, two main anchor blocks were required on the Nebraska side. In each one, thirty-four 12-in. "H" piles of 53 lb per ft were driven to a minimum bearing of 47 tons. Each block required 503 cu yd of concrete and 12,096 lb of reinforcing steel. The sectional construction method and same type of bolts were used as on the Iowa side.

The wind anchor blocks on the Nebraska side have sixteen 12-in. "H" piling driven to a minimum bearing of 43 tons. Each required 207 yd of concrete and 6377 lb of reinforcing steel. Again the two section method was used. Totals for piling driven on the Nebraska side were: Main anchor blocks, 4365 ft, and wind anchors, 1467 ft. Concrete in all anchorage blocks had a 28-day compression strength of 4000 psi and cement used was Type II, modified heat of hydration, Portland cement.

Main Piers and Towers

In order to reach solid bedrock for the main piers on either side, caisson construction was necessary. The hydrostatic head encountered required working pressures in the caissons up to 32 psi in the final phase.

Sub-contractor for caisson construction was Dravo Corporation, Pittsburgh, Pennsylvania, who appointed E. E. Weeter as superintendent. Representing Northern as pneumatic operation inspector was Kenneth Arterburn, Jr., who took a leave of absence

A hospital lock and doctor were ready to deal with any case of the "bends" suffered by sand hogs during caisson construction.

Site of Northern's pipeline suspension bridge (above) from the Nebraska side with caisson work proceeding on both sides.

from Texas Illinois Natural Gas Pipeline Company to assist Northern.

Two caissons were sunk for each main pier, for a total of four caissons. The concrete lifts poured at the excavation point were 24 ft in diam. The first lift had a welded, structural steel cutting edge. On the Nebraska side, the first three lifts were sunk by open dredging method through an 11-ft dredge well in the center of the lifts. As material was removed from the center of the dredging well the lifts settled of their own weight. After sinking three lifts in this manner pneumatic operations were used on the last two lifts.

Every safety precaution was observed in these operations. Facilities included a hospital lock, a doctor in attendance at all times, stand-by power and air facilities, a carbon monoxide warning system, and equipment to constantly check pressures.

Access to the dredging well included a man air lock and a materials lock for removing excavated material. Initial pressures in the caisson when pneumatic operations began were 12 to 14 psi. Sinking of the lifts under pneumatic operations totaled 30 and 36 ft respectively for the two Nebraska caissons and 20 and 18 ft for the Iowa side. On the Nebraska side, five lifts were used for each caisson and seven lifts were necessary for each caisson on the Iowa side.

The cutting edges were landed on bedrock at about 70 ft below ground level on the Nebraska side and 95 ft below ground level on the Iowa side. Fourteen-foot test holes were drilled to confirm the caissons had reached bedrock.

At bedrock, key trenches were cut in preparation for a concrete seal. These trenches and some previous excavation was done with blasting, supervised by a representative of the DuPont Company.

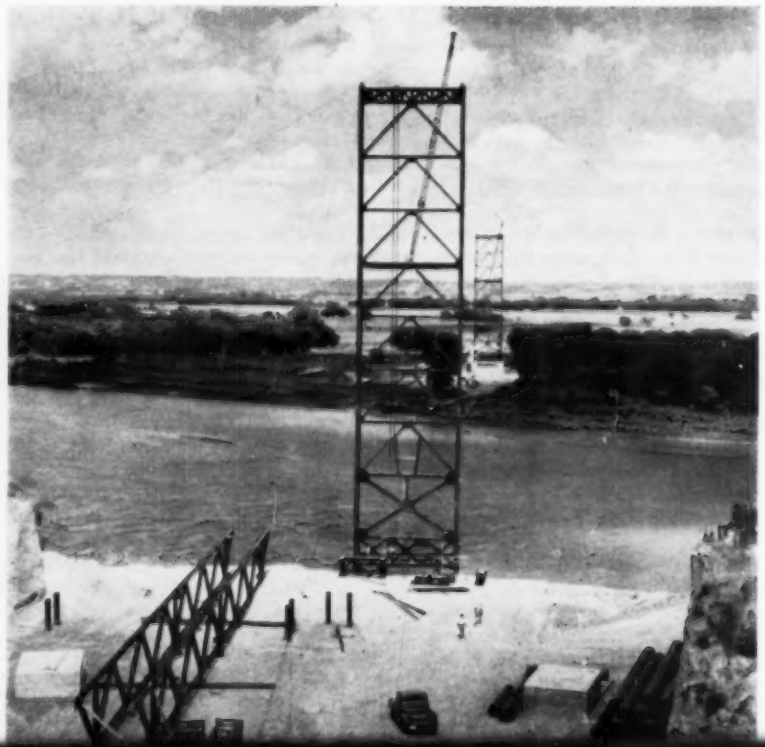
The seals poured in each caisson required 271 cu yd of concrete. These seals were poured under pressure sufficient to prevent invasion by water. The seals were 24 ft in height and keyed into bedrock. Concrete used in the seals had a 28-day compression strength of 4500 psi; Type I, Portland cement.

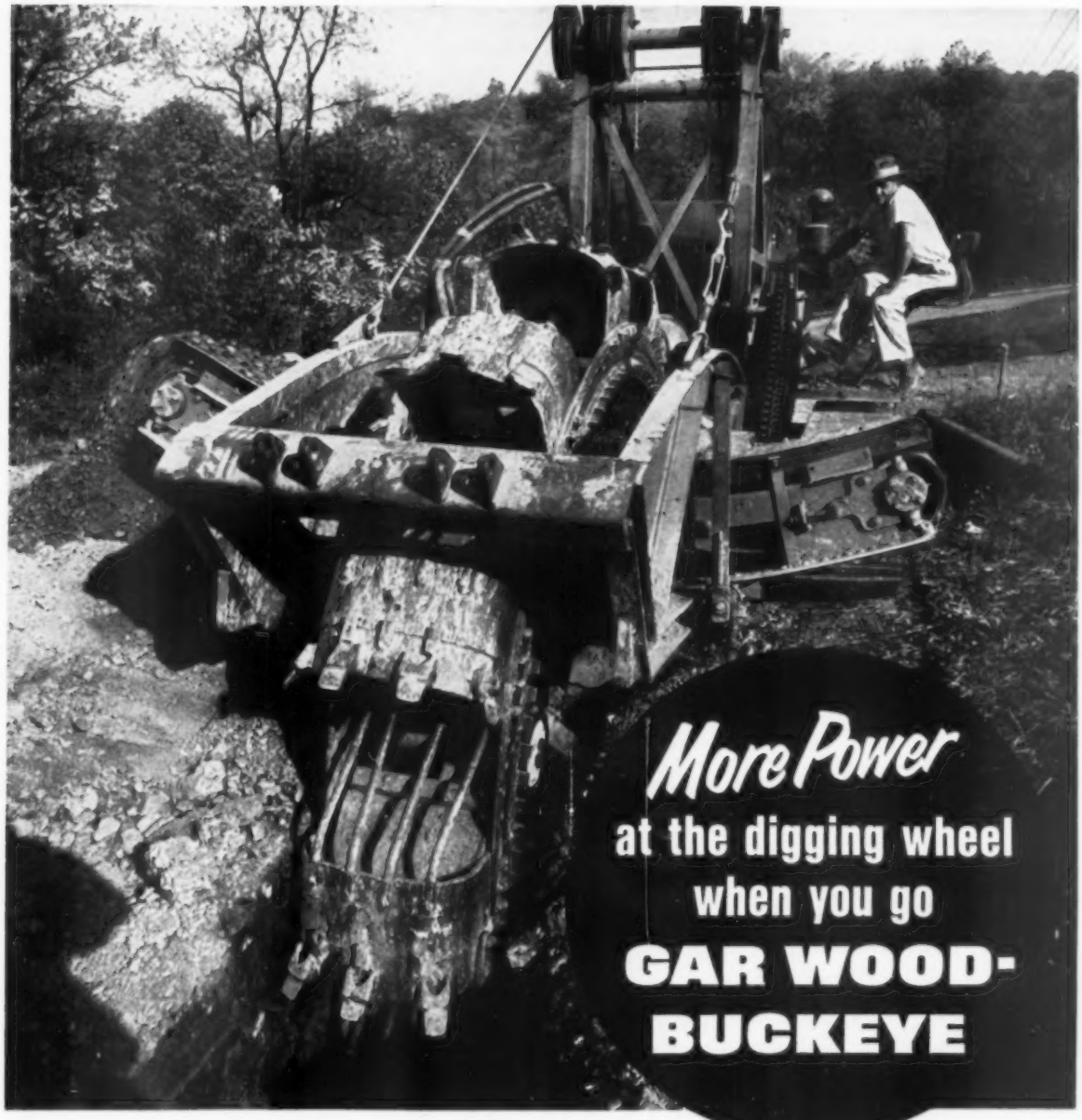
Caissons were each 19 ft from bridge center line and following completion of caisson forms were raised for ice breakers and pier shafts. In the caissons, pier shafts, and ice breakers, a total of 162,267 lb of reinforcing steel was used on the Nebraska side and 241,379 lb on the Iowa side.

During the pier shaft pouring, eight anchor bolts were set in each shaft to accept the rocker base casting for structural steel. These anchor bolts were 3-in. round, 10 ft long, with 3-ft, 3-in. projecting above the bridge seats on the shaft. These seats were machined down to a true horizontal plane. Before the rocker casting was seated, four layers of 12-oz duck and red lead paint were applied.

Erection of the main towers was completed in three nearly equal sections. As each tower column was

The bridge site from the Nebraska side. At lower left and right are the wind anchor blocks. Structural steel at lower left is for truss span.





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GarWood Buckeye

GAR WOOD INDUSTRIES, INC.

Wayne, Michigan • Findlay, Ohio

placed on its rocker base, it was guyed and all cross members were bolted or held by drift pins. As each succeeding section was erected the same method was used until installation of the top strut 185 ft above the pier seats. All rack and whine were eliminated with the guy wires and drift pins. All rivets were ⅞-in. round and inspected under standards approved by the American Association of State Highway Bridges.

The four wind arms, 99½ ft in length and 24 ft in depth, were fabricated on the ground and erected as a unit. A total of 795,000 lb of steel was used in both towers.

Rest Pier and Tower

Pilings for the rest tower pier were twelve 12-in. "H" piles driven to a minimum bearing of 43 tons. A total of 951 ft of piling was driven. The pier required 80 cu yd of concrete of 28-day compression strength of 4000 psi with specified Type II Portland cement. Reinforcing steel totaled 6578 lb. The bridge seats used on the rest pier were recessed and tower columns rested on rocker plates. Wedges on opposite sides of the plate were used for rocking the tower. The tower is 76 ft in height. Wind cable sheaves are 43.5 ft above the base. Similarly, cable castings were installed on top of the tower for the main cables.

Truss Span

As mentioned before, the contour of the land on the Nebraska side required a 154-ft truss span extending from main tower to a pile bent on the bank. Four 12-in. "H" piles were driven to refusal. At the tower connection expansion bearings were used and at the pile bent fixed bearings were installed.

Bridge Cables

The main cables were composed of three 2¾-in. pre-stressed galvanized steel bridge rope. Ultimate strength of each main cable bridge rope in a simple direct tension was required to be not less than 694,000 lb. Each main cable rope was pre-stressed for not less than five hours under a tension of not less than 40 per cent of ultimate strength.

After pre-stressing these cables were put under a tension of 194,200 lb at 68 F, which was maintained while cables were accurately measured to length and marked for positioning upon towers and for location of suspenders and supports.

The two wind cables were 2½-in. diam, pre-stressed, galvanized steel bridge rope. Specifications called for an ultimate strength of not less than 576,000 lb under direct tension. Each cable was pre-stressed for not less than four hours at not less than 50 per cent of ultimate strength. A tension of over 15,000 lb was maintained at 68 F for accurate measurement and marking. Main suspenders, wind guy suspenders, wind cable incline supports and incline diagonal supports were ⅝-in. diam, 19 main wire galvanized strand with Class A zinc coating. All fittings were galvanized, drop-forged steel.

Cables were received at the construction site on spools and a reel fabricated on the Iowa side to facilitate pulling. After the first cable was pulled all specified adjustments were made on this as a pattern for the remaining cables. Specifications required that the adjustments be made under overcast skies or at night with a temperature range of 67 to 70 F. The remaining five cables were pulled and adjusted to the lead cable's sag and tension. The total suspension system of the bridge totals approximately 188 tons.

Pipe

The two 30-in., ½-in. wall thickness, 157.6 lb per lineal foot, gas lines are suspended by the bridge. To equalize stresses on the pipe floor beam, the pipe was double jointed on the Iowa side during construction and triple jointed on the Nebraska side. Final welds were made at approximately mid-span over the Missouri River. Expansion is taken up on the Iowa side by a 53-ft riser and hair pin, while on the Nebraska side a horizontal leg supported on lubrite bearing plates allows for shifting. Total weight of the two lines is approximately 400 tons. Lowest point of steel over the water is 70 ft above standard high water level, nearly 20 ft more than required by the U. S. Army Engineers.

The Author

C. A. McReynolds, senior engineer for Northern. As head of Northern's Pipeline Engineering Section, he was responsible for the bridge project. He has 16 years' experience with Northern.

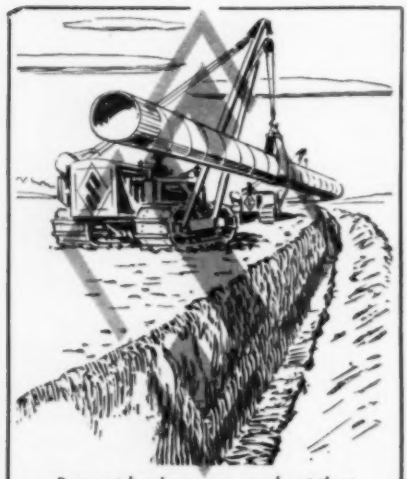
Final adjustments were made before dawn at 68 F. The result was a 3.62 ft camber in the main span and both main towers were leaning back ½-in. The lines were purged and put in service.

Painting and Lighting

The majority of structural steel was sand blasted and primed after erection. After sand blasting four coats were applied to the steel. They were: Maritime Commission zinc primer, 350 gal; No. 85 damp proof primer, 450 gal, and two coats of Rust-No aluminum, 450 gal. Aluminum was used alternately with Transport CAA orange, 300 gal, for air navigation and warning marking.

Lights on the tower include two beacon lights on each main tower and three navigational lights. In each case there is an operating light and a standby with automatic relays and current breakers to turn on the standby in case of failure of the operating light. Lights are automatically turned on by a photo-electric eye.

Completed and now in service, the largest suspension bridge on the Missouri River gives Northern the versatility needed at a critical point. With two 20-in. undercrossings, two 30-in., and one 24-in. overcrossing the system is designed for any emergency situation. Northern feels it has crossed another bridge to better service. ★ ★



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HOW TGT GETS TOP EFFICIENCY

O. H. Moore
Director, Operating Research
Tennessee Gas Transmission Company

Improvements made to system by:

- *Exchanging power cylinder heads*
- *Turbocharging engines*
- *Installing large clearance cylinders*
- *Redesigning station piping*
- *Cooling engine intake air*

TENNESSEE Gas Transmission Company's high pressure, multiple pipe line, gas transmission system extends from the Mexican border to the New England seaboard, with wide variations in the types of operating problems encountered throughout the line. This calls for constant vigilance on the part of the compressor department personnel to keep pace with problems in the operation of the compressor equipment required to move upward of 2 billion cu ft of gas per day.

Even though an extensive long-range study is made in the initial plans as to capacity, pipe size, compressor station spacing, gas purchase, and gas sales points, many complicated problems enter the picture when a company expands almost 10 times its initial size in a span of 12 years.

Tennessee Gas, at present, has 27 main line compressor stations with a total of 537,720 hp working on the gas stream. Daily figures on labor cost, fuel and oil used, supplies and maintenance costs are quite large for the operation of equipment of this magnitude.

The daily labor cost for 1955 was in five figures. Fuel consumption of 93,000,000 cu ft a day is about one-half the initial capacity of the system, and the equivalent of a 3000-gal transport truck is required to make a daily trip to keep the system supplied with lubricating oil.

The volume of gas transported daily by the company is of such magnitude that a slight improvement in the efficiency of the compressor equipment often returns the cost of obtaining that improved efficiency many times. Specific fields of improvement have been in more efficient compressor cylinders, better fuel economy, and higher compression and turbocharged engines.

The present day installation cost of new compressors makes the modification of old equipment an attractive project at almost any conversion cost. This is especially true in compressor buildings that already have reached their ultimate design in the number of installed units. Increasing the horsepower on the individual units does not call for an increase in the number of employees and, in almost every case, improves the fuel economy of the engine.

TGT'S Method of Increasing Horsepower

1. Compression Pressure

Raising the compression pressure is a definite possibility for most of TGT's engines. Where this is done, we get a flat 10 per cent increase in horsepower, with a resulting improvement in fuel economy. This conversion to higher compression is accomplished through exchange of power cylinder heads.

2. Tailored Scavenger Air

Experimental work on 2-cycle engines indicates that an additional 5 to 7 per cent increase in horsepower is available through cooling of the intake air to the engines. Heat exchangers were placed between the scavenger air cylinders and power cylinders to remove the heat of compression from the intake air. This cool intake air also resulted in an improvement in fuel economy. (See Fig. 1.)

3. Turbocharged Engines

Sufficient operating experience is now behind the first installation of turbocharged equipment on 2-cycle engines to prove that this type unit can be operated in this manner. There are two types of installation: (1) The pulse type calling for individual exhaust lines from the cylinders to the exhaust turbine, and (2) the constant pressure type where a common header to all cylinders carries the exhaust gases to the turbine.

Starting of engines with either type installation is not too difficult, and there does not seem to be any end to the extent of load they will carry so

Presented before Ninth Oil Recovery Conference, sponsored by Texas Petroleum Research Committee, Texas A & M College, College Station, Texas, under the title "Improved Operating Techniques and Gas Compressor Equipment."

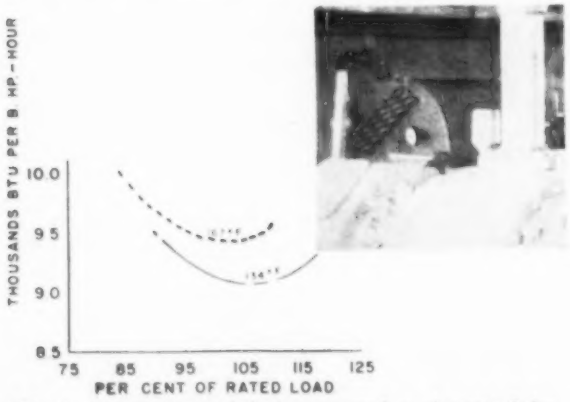

FIG. 1. Comparison of fuel consumption characteristics of an engine with cooled versus non-cooled scavenger air.

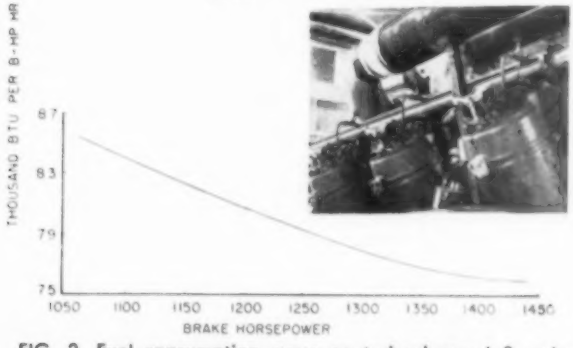

FIG. 2. Fuel consumption curve on turbocharged 2-cycle engine.

long as there is sufficient scavenger air. The fuel curve takes an entirely different shape from that of one from the conventional type 2-cycle engine.

Fig. 2 shows the type of fuel curve obtained from a turbocharged 2-cycle engine.

Station Piping

The volume of gas moving through TGT's network of piping requires a careful study on the part of the designing engineer. Excessive pressure drop through a station yard, or inadequate design of the piping to even an individual engine, can offset the expected increase in station efficiency when making a change in construction to gain more horsepower. A billion cubic feet of gas is a lot of gas, but upwards of 2 billion cu ft per day is a lot more gas. To handle this volume a single station horsepower requirement goes up to approximately 40,000 hp. This means a complicated network of yard piping.

Within the multiple-building compressor station, it is possible to attain a wide variation of horsepower requirements, even when throughput, pressures, temperatures, and station header ratios of pressures remain constant. The variation in horsepower requirements is caused by varying the relative proportion of the total flow that each engine room handles.

Pressure drop in gas lines depends approximately upon the square of the flow, and required horsepower depends upon the ratio of pressures, which is a function of the pressure loss. Therefore, other conditions remaining constant, it takes more horsepower to compress a cubic foot of gas at high flow than it does at low flow. Hence, operating costs rise higher as the flow increases.

Company engineers have been aware of this problem and, for the past several years, have been actively engaged in pressure drop studies on the main lines and in the station yards, always searching for ways to keep operating costs at a minimum and operating efficiency at a maximum.

A study of station yard piping has necessitated a "lot of doing" and we feel that we have approached the problem in a manner that appears to have merit in its application. TGT's C. H. Klohn has adapted the Hardy Cross method of analyzing a flow network to a particular problem of compressible flow. The Hardy Cross system is based on the principle that a fluid will automatically assume the most efficient distribution through the network.

That is, if in Fig. 3 you put into the system at A and take out at D, the algebraic summation of the pressure drops AB plus BC plus CD must equal the algebraic summation of the pressure drops AF plus FE plus ED.

The Hardy Cross system has been simplified to the extent that all you need to know to use the proposed method of calculation is the per cent of flow through each of the different compressor buildings. After you have this per cent of flow, you can then calculate the pressure drop for any temperature, any pressure, and any total flow through the station yard network.

Yard piping has been redesigned at several stations, which has resulted in savings up to 1200 hp, with a corresponding increase in gas compressed without the addition of extra horsepower.

Compressor Cylinders

The development of the large clearance cylinder was a necessity in long line gas transmission service. Operating pressures at the compressor stations do not change materially from day to day, but there is a definite change from year to year in an expanding company. The extent of change will vary with the type of expansion program. The effect of this program is best shown by a plot of the ratio of pressures for 10 years of operation for TGT.

Fig. 4 is a typical example of the constant changes experienced in the operating pressures at TGT's compressor stations. The ratio of pressures appears to be leveling out at about 1.4, having dropped from 2.0 ratio for the initial design.

The peaks and valleys in the graph are the results of construction programs either at this compressor station or on the main line, such as addition of compressor equipment or main line looping. This construction does not necessarily have to be at a given station or on the main line adjacent to a station. The addition of compressor equipment or the looping of the main line at other stations will result in changes in the operating pressures at several stations. The greatest effect is, of course, felt at the station nearest the construction. The tie-in of a new sales point or, for that matter, a tie-in of a new gas purchase point will have their effect on the operating pressures.

Generally speaking, the peaks in a ratio of pressure curve are the results of the installation of additional horsepower, and the valleys are the results of main line looping. This is especially true in the early years of operation of a pipe line system. These changes in the ratio of pressures are going to be rather stable on TGT's system from now on because of the size of the network of the system. Most stations on the line already have become so large that the installation of additional compressor equipment will have minor effect on the operating pressures as compared to what an equivalent installation would have had in the early years of operation. This same thing is true for construction of additional pipe line facilities.

These changes in ratio of operating

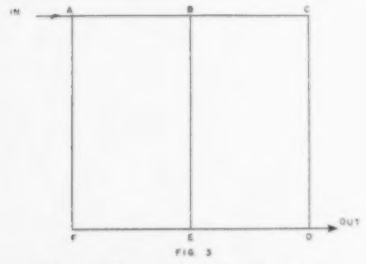

FIG. 3. Illustrating the Hardy Cross system of analyzing a flow network.

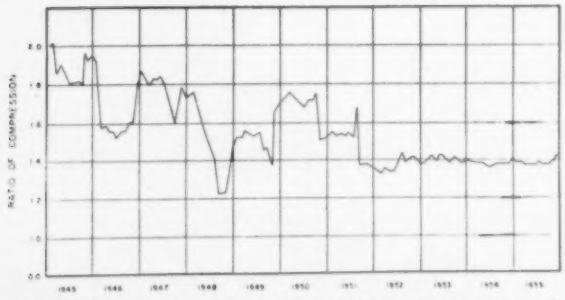

FIG. 4. Eleven-year record of monthly average ratio of pressures.

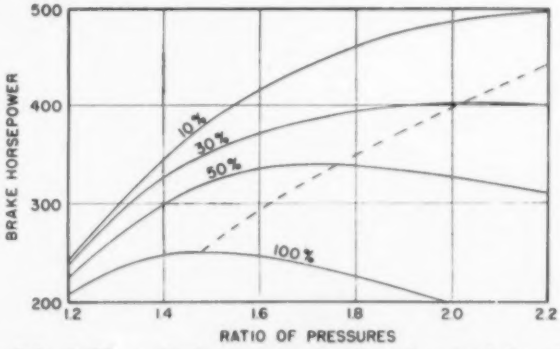

FIG. 5. Effect of clearance on loading characteristics of compressor cylinders.

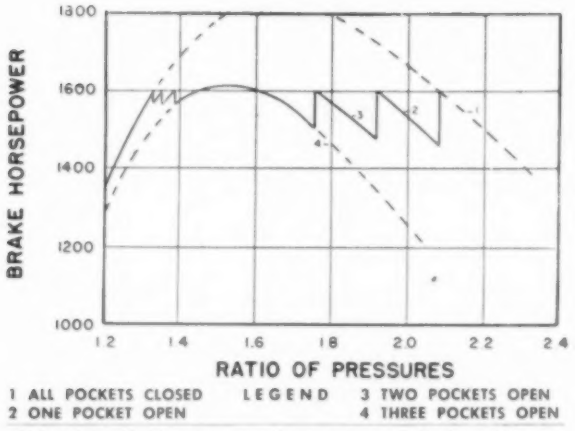

FIG. 6. Typical load curve of compressor cylinder with variable clearance pockets.

COMPOSITE WASTE CURVES FOR FIVE COMPRESSOR CYLINDERS

CURVE END	BORE SIZE	NO. VALVES PER END	PER CENT CLEARANCE	VALVE LIFT AREA IN SQ. IN.
A	7 1/2"	2	9.5	5.51
B	7 1/2"	2	11.3	5.893
C	10	4	14.2	9.32
D	8 3/4	4	20.2	9.32
E	13 1/4	4	59.4	26.11

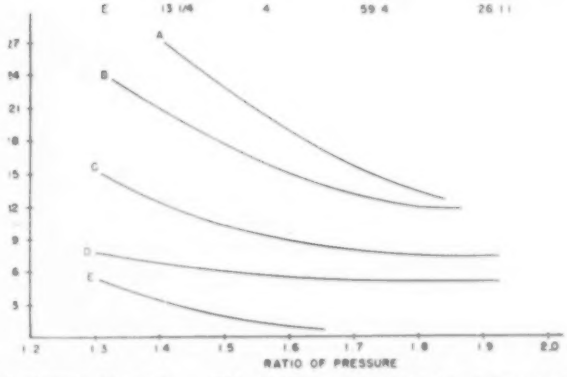

FIG. 7. Per cent waste in compressor cylinders versus ratio of operating pressures.

pressure affect the loading characteristics of a compressor cylinder in direct relation to its per cent clearance.

Fig. 5 depicts the effect of clearance of the loading characteristics of a compressor cylinder operating under different ratios of pressures.

Most of the compressor cylinders purchased on our initial engines had fixed clearances in the range of the 10 per cent curve with one clearance pocket in the head end of the cylinder. As the operating ratios of pressure dropped through the years, these cylinders were changed out in favor of cylinders with larger clearances. Cylinders with clearances in the 10 per cent range are best suited for ratio of pressures above 2.0. This is best shown from Fig. 5, where a change from 2.0 to 1.4 ratio means a reduction of approximately 28.5 per cent in the load factor. whereas a cylinder with 50 per cent clearance would have a load factor change of only 0.8 per cent.

An increase in per cent clearance means a reduction in the horsepower of the cylinder. To maintain the horsepower, therefore, cylinder diameter must increase. This means bigger cylinder bodies, that, in turn, permits larger gas passages and/or the installation of more compressor valves in each end of the cylinder or, if preferred, larger valves. This improved design lowers the pressure drop within the cylinder proper, releasing more horsepower to pump gas.

Fig. 6 is a typical load curve on new compressor cylinders purchased under the present policy in the selection of cylinders. The cylinder size and total per cent clearance is selected so as to give full load with maximum clearance at the expected ratio of operating pressures. This clearance is then divided between fixed clearance and clearance pocket in order to spread the load range through as wide a range as desired. At low ratios of pressures, all pockets are operated closed; then as the ratios go up, clearance pockets are opened to prevent the cylinder from overloading.

This change in clearance progresses in steps until maximum clearance is reached. Should the ratio of pressures continue to rise, the horsepower would begin to drop off due to the effect of excess clearance on the loading characteristic of the cylinder. Clearance pockets are then closed in steps, each in turn decreasing the per cent clearance, bringing the cylinder back up to rated load.

Cylinders of this type permit peak operating efficiency through a wide range of ratio of pressures.

Fig. 7 represents the type of improvement that we have accomplished in the operating efficiency of the compressor cylinders through a better selection of cylinders.

Fuel Consumption

Fuel consumption on a long line transmission system is of major importance. Gas is compressed again and again as it moves up the line and, at each compression, gas is used out of the line to provide the horsepower necessary to raise the gas from the suction pressure on the inlet side of the station to discharge pressure on the outlet side. The value of this fuel gas theoretically becomes that of the sales price of the gas once it reaches the point on the system where there is no more gas put into the system from the sources of supply.

Any savings, therefore, in fuel consumption affects the economy of the system. The best data showing the improved fuel consumption experienced on the TGT System is that showing the comparison by years of cubic feet of fuel consumed versus cubic feet of gas compressed.

Fig. 8 represents the comparison of cubic feet of fuel consumed per thousand cubic feet of gas compressed by years, plotted against ratios of pressures.

Fig. 9 is another comparison of fuel used versus gas compressed. This 5 per cent increase in total fuel consumed from 1952 to 1955 compared to the 24 per cent increase in gas compressed represents a change from 7.06 per cent to 5.96 per cent of total fuel consumed, versus total system delivery. This im-

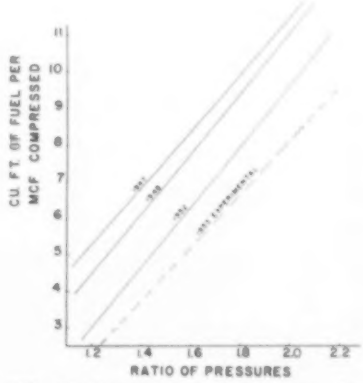

FIG. 8. System average figures for cubic feet of fuel consumed per thousand cubic feet of gas compressed.

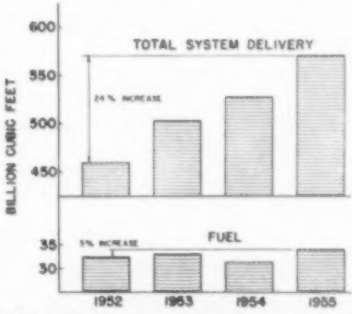

FIG. 9. Four-year comparison of total gas compressed versus total fuel used.

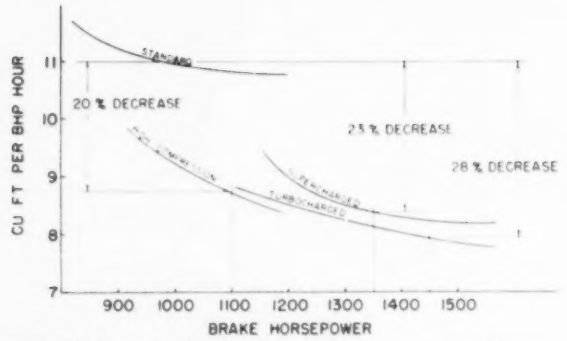

FIG. 10. Comparative fuel consumption curves on Cooper-Bessemer GMV-10 engines.

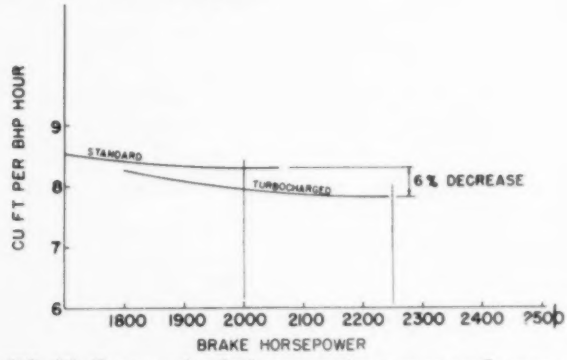

FIG. 11. Comparative fuel consumption curves on Cooper-Bessemer GMW-8 engines.

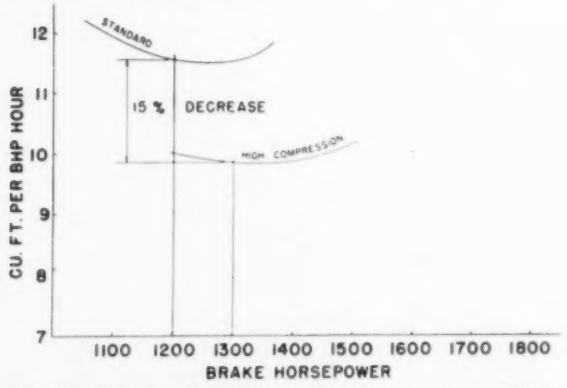

FIG. 12. Comparative fuel consumption curves on Clark Bros. BA engines.

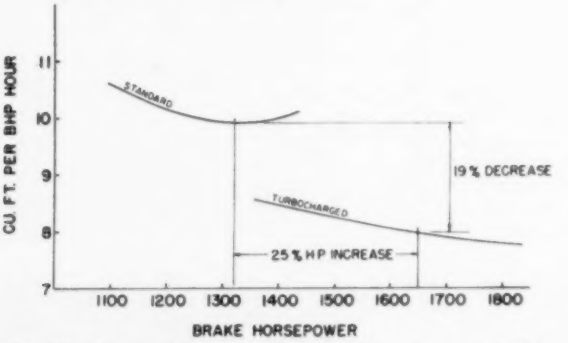

FIG. 13. Comparative fuel consumption curves on Clark Bros. HBA-6 engines.

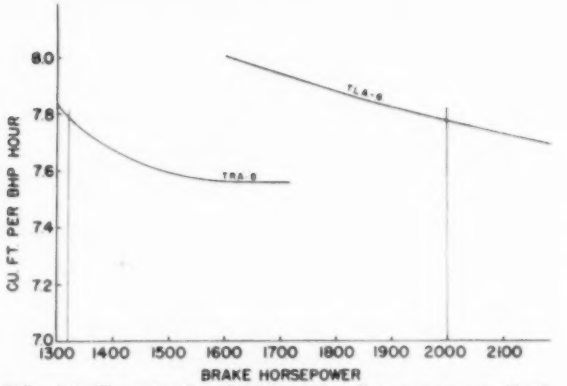

FIG. 14. Comparative fuel consumption curves on Clark Bros. TLA and TRA engines.

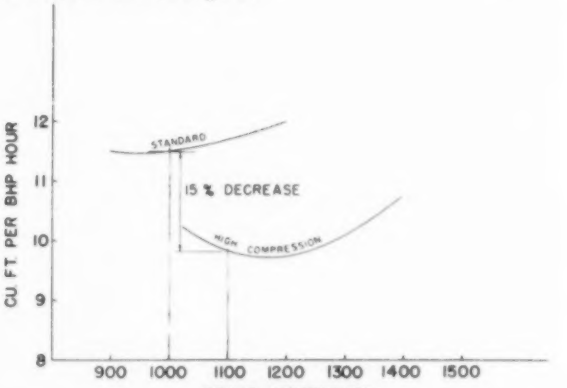

FIG. 15. Comparative fuel consumption curves on Worthington LTC-8 engines.

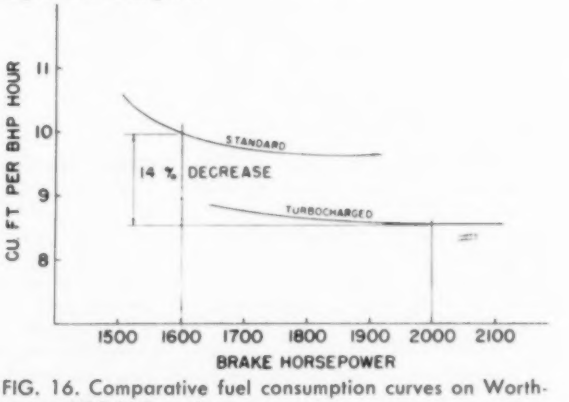

FIG. 16. Comparative fuel consumption curves on Worthington UTC-168 engines.

provement in fuel consumption as represented in Fig. 8 is the result of more efficient compressor cylinders, improvements in fuel consumption characteristics of the individual engines, and the improvements in the overall design of the station yard piping and the main line network.

The improvements realized in the fuel consumption of the individual compressor equipment are best shown in Figs. 10 through 16.

These improvements are the results of the combined effort on the part of the engine manufacturers and TGT's compressor department personnel working together for the common cause — higher efficiency means more dollars in the till. ★ ★ ★

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— Photos Courtesy UNITED GAS LOG

Less exciting than construction, perhaps, but vital to the success of any major pipe line project is the immense amount of work, planning, and design that goes on behind the scenes

P 623

PIPELINES Don't Just Happen!

Editor's Note: *We are indebted to United Gas Pipe Line Company, Shreveport, Louisiana, for permission to reprint this article from the UNITED GAS LOG, which describes "why" a pipe line is built. The article takes you "behind the scenes" for an on-the-spot report of the development of an actual pipe line project with the men responsible for such exacting planning.*

THE rugged drama of pipe line construction has been portrayed for millions of readers in recent years as the natural gas industry moved in rapid ascent toward its position as the nation's sixth largest industry.

Nowadays those even remotely familiar with the industry know that the sight of pipe-stringing trucks, sideboom "cats" and a welders' "firing line" symbolizes new pipe line construction underway. What many unknowingly overlook is that part of the story they never see: The vast amount of study, planning, and design that precedes construction. In one sense it's like entering a theater in the middle of a movie. The why, the who, and much of the plot are missing.

The story of modern pipelining begins long before the first piece of construction equipment moves on location. For every month spent in building a pipe line, two months, three months, four months—perhaps longer — are spent studying, analyzing, planning, designing, and working out an infinite number of details.

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Many men take part in the building of pipe lines. One of those playing a specialized role is the surveyor. Here, C. B. Davis, United Gas Pipe Line instrument man, and his transit are shown on survey of a new pipe line route.

Early pipe line planning often brings discussions, conferences between members of engineering, operating, and other departments. Left to right are M. V. Cousins, vice president in charge of operations for United Gas Pipe Line; R. U. Vandervoort, manager of pipe line sales and rates; L. C. Poindexter, eastern division general pipe line superintendent; Paul Williams, chief engineer, at map; C. C. Barnett, vice president in charge of gas supply; J. D. Davis, western division general pipe line superintendent; and R. H. Feild, engineer.

Many departments and many considerations are involved in major pipe line proposals. Above, R. H. Feild of the economic planning section of general office engineering and Max P. Watson of gas supply check figures. At right, Paul Williams (left), R. A. Woodall, and R. H. Feild study aerial photographs and maps used in selecting preliminary pipe line routes.

How Pipe Lines Get Started

No pipe line is built without specific reason. There must be a purpose, i.e.—tie in new sources of supply, serve new customers, or bolster system capacity in line with area growth and demand for gas. Sometimes even the so-called smaller projects cost in the hundreds of thousands of dollars. Larger lines require expenditures ranging into the millions.

Pipe lines aren't built to lose money. Such expenditures must be thoroughly justified from standpoints of cost and expected return. Hence, in the earliest stages of any major project come economic studies, projected for years into the future, to estimate building and operating costs, anticipated revenues, and rate of return from the new facilities.

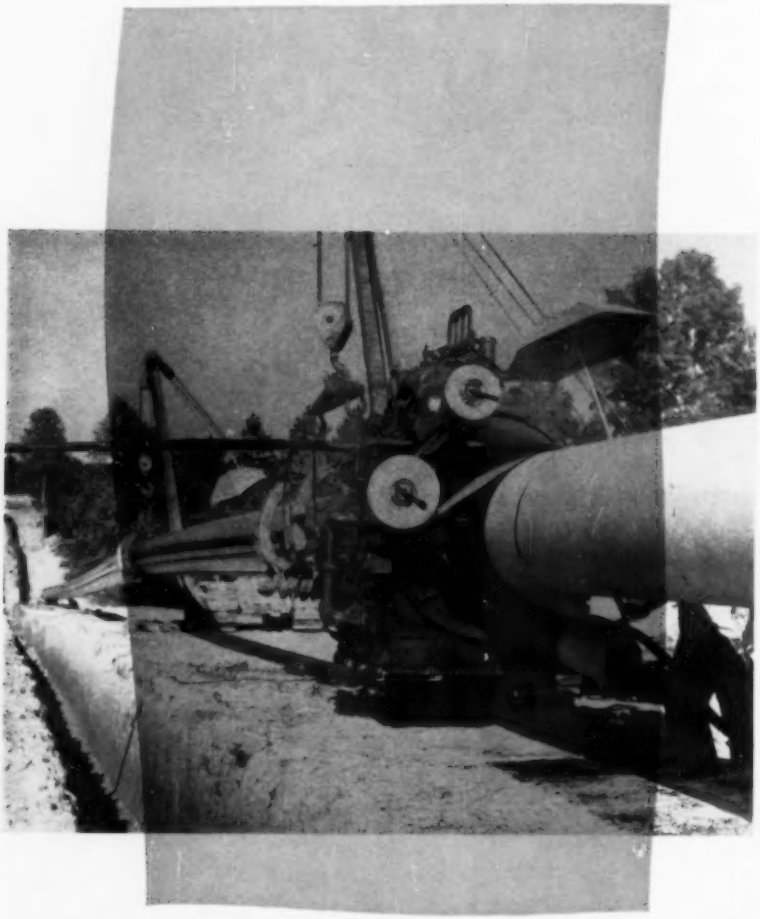
Once a decision is reached, an exact route must be picked and surveyed. Right of way must be obtained. All physical facilities must be planned and designed to afford maximum operating efficiency over a period of many years. Many details must be worked out by members of engineering and operating departments. Frequently, permits and certificates must be obtained from various agencies and regulatory bodies. Detailed specifications of construction must be assembled, and invitations for construction bids prepared.

Every pipe line is built on paper long in advance of the time its physical counterpart goes in the ground. This is the part of present-day pipelining that is little known.

From Conception to Construction

No two pipe lines are alike in all respects. The nature of the project, the certainty of whether or not it will be built, the expediency with which it must be executed, and many other factors help govern the time and sequence that moves a project from the planning to construction phases. With all the variables present however, most major pipe lines undertaken follow similar patterns of planning and design.

From the time management decides to build a major pipe line project, or to explore the possibilities of such a project, many men take part. Initiation of general planning may bring about early discussions between management, engineering, and operating representatives.



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Economic Planning

Most projects are channeled immediately into the economic planning phases. What size line and other facilities will best serve the purpose or need? What is the best route? What will it cost to build and operate? What is the relationship between total investment and anticipated revenues that the project will create?

It must be remembered that in a vast and complex system — such as that of United Gas, portrayed in this article — there often exists more than one possible avenue of expansion to meet a particular need. Consider, for example, a hypothetical need for additional gas is one portion of the system. How can the need best be met? Perhaps increased compressor horsepower or the looping of an existing line — or both — will be most practical. On the other hand, long range studies may show that construction of a new transmission link is the most advisable. To find the best answer, engineers must take each possible plan of approach and work it out in its entirety.

Many factors, present and future, not only have to be considered, but calculated in realistic terms. The best answer to even a localized problem sometimes requires a maze of study involving gas flow formulas, pipe line capacities, operating pressures, horsepower and load factor for an entire portion of the system.

Proposals to connect new sources of supply often involve long range studies of fields and gas reserves. When and to what extent will field pressures decline? What other sources of supply may become available in the area? What will it cost to gather, dehydrate, compress, and transport the gas?

Anticipated sales revenues from proposed transmission lines also are projected as far into the future as possible. Annual gas requirements of new industries, for example, are estimated not in terms of one or two years, but for as many years as can accurately be forecast. Can deliveries be expected to increase, decrease, or remain relatively constant over a long period? All such factors bear heavily on the feasibility and ultimate design of any project.

Sizing of a pipe line is a decision of utmost importance. Estimated volumes, operating pressures, and other factors are measured against the relationships of pipe sizes, capacities, and costs of construction to determine a line's size. The planning engineer knows for instance that a 24-in. line can be constructed for approximately 1½ times the cost of a 16-in. line, and yet will provide approximately three times the capacity of a 16-in. ($50,000 or more per normal mile for 16-in. construction, and $75,000 or more per

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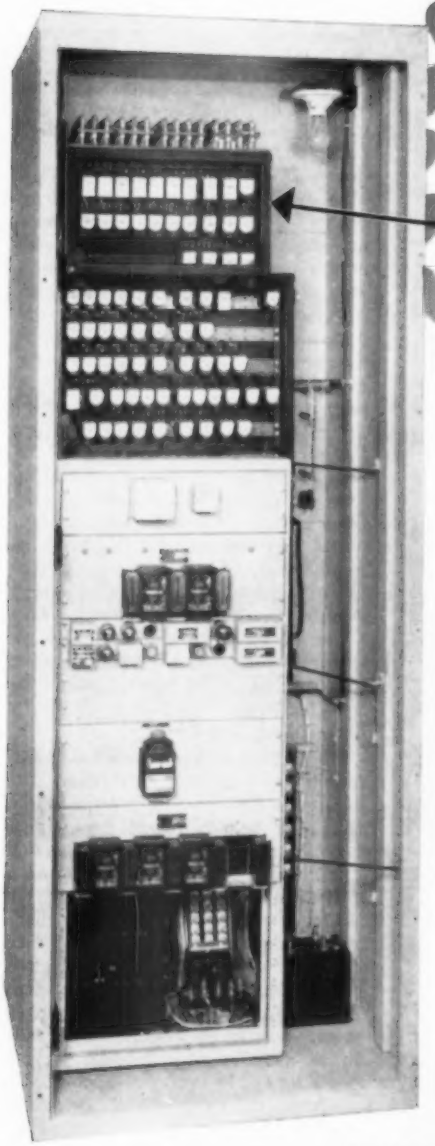

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This is an example of the reliability that is built into the components used in the UNION C.T.C. System. It means that you can expect a UNION System to go to work and *keep on working* with the least possible maintenance cost. Write for a copy of our Bulletin SPL 1052 for complete information.

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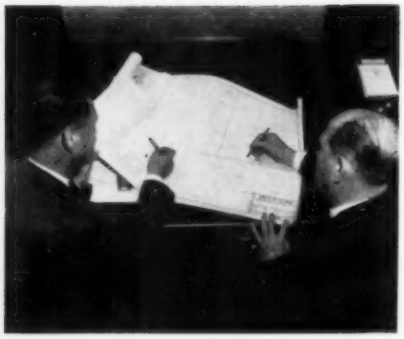
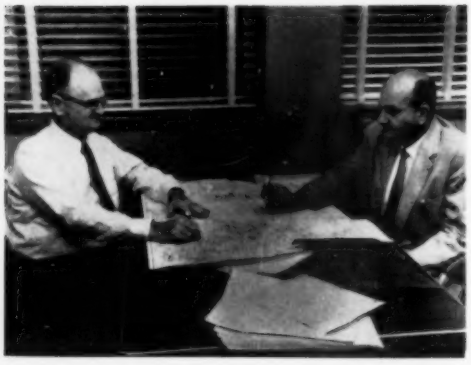


Preparing an expenditure requisition to cover cost of a new line are J. C. Young, senior clerk, left, and W. R. Wade, chief clerk of general office engineering.



In the economic planning section, each major project is thoroughly studied from many economic standpoints. Engineers J. C. Nelson, left, and W. P. Givens are shown in a discussion session.

Construction costs for every section are estimated in the early stages of planning. Frank McCarthy is shown making tabulations.

Final detailed design work for a new pipe line project is responsibility of the pipe line design section. Engineers M. B. Johnson, left, and R. D. Cunningham are shown checking a section.

Final construction drawings are made by the drafting section of the engineering department by such men as W. W. Wilson, left, chief draftsman, and B. A. Thorne, senior draftsman.

mile for 24-in.). A 30-in. line cost approximately 1¼ times as much to build as a 24-in., but provides almost twice as much capacity. What size line — all other factors known or accurately estimated — will provide sufficient capacity and afford the lowest cost per 1000 cu ft of gas?

Picking the Route

Nature and the works of man seldom, if ever, let the pipeliner follow a straight line. Natural obstacles, cities, towns, and farmhouses always lie somewhere along a straight line between two points. The pipeliner must pick his route accordingly.

Selection of at least a tentative route is done early in the planning of any new pipe line. Using such initial guideposts as existing aerial photographs, sectional aeronautical charts, and ownership, hydrographic and other maps, engineers plot the most feasible route from point of beginning to destination. New aerial photographs are often taken of a strip approximately three miles wide along the proposed route to provide an up-to-the-minute picture of terrain and conditions. Pieced together in map form, scaled 1-in. to 1000 ft, the aerials bare many conditions the pipe line planner must consider.

In many cases, preliminary field investigations by district and general office personnel will be made to verify aerial data and seek additional information that will help in the exact routing of a line and in planning design details. Construction engineers help select the best routes through residential areas, most suitable points for river crossings and other control points.

Estimating the Cost

Such things as annual rainfall, population per square mile, and labor costs are more than passing figures to the men who help plan and design pipe lines. It takes information like this and much more to compile construction cost data on a proposed project.

Only by continually reviewing fluctuating costs and by stockpiling data from past construction jobs can United Gas engineering personnel make accurate estimates. They know approximately how much it will cost per mile to lay each size of pipe under varying conditions of terrain. These are known as basic estimates. Level to rolling country, for example, is best for construction purposes and means less outlay in terms of construction cost. Cost goes up somewhat in hilly country and more so in low, wet terrain. In areas where ditch must be dug by dragline or from barge equipment operating in canals, it goes correspondingly higher. Likewise with lake crossings and other unusual features.

Right of way buyers follow close behind survey crews to acquire necessary right of way. Above, C. W. Luse, right of way buyer, checks route map in field office. Below, W. H. Holt, party chief, left, confers with C. E. Copeland, senior inspector.

Using their basic estimates to compensate for differences in terrain, engineering personnel calculate construction costs for every section of line. Additional expenditures for each road, highway, railroad, or stream crossing are included to make the estimate as realistic as possible. When major stream crossings are involved, a separate and complete estimate is made for each.

Estimates for installing all appurtenances necessary to the project, plus estimated costs of coating, cathodic protection, X-ray weld inspections, and hydrostatic testing of the line when it is completed are added thereto. Every requirement of the project is taken into consideration and allowance made in the cost estimate.

One last adjustment is made to the total estimated cost of construction. The final figure is adjusted in relation

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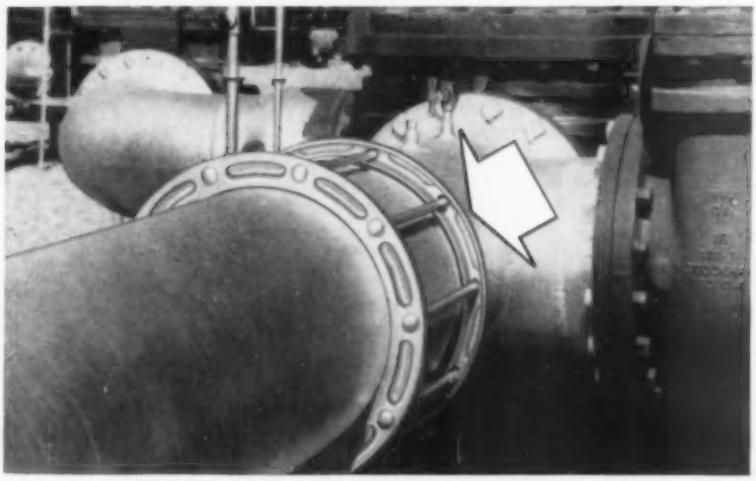

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to past experience with construction in the general area for which a new project is proposed. Planning engineers apply what they term a "district seasonal factor" to reflect varying conditions in each area of the system. In United Gas Pipeline Company, each pipe line district has its own average seasonal factor based on annual rainfall and other elements and conditions that affect construction. These range from a low of 0.92 for San Antonio district to highs of 1.06 for New Orleans district and 1.08 for Jackson district. The appropriate factor is multiplied by total estimated cost to get the final construction estimate.

Cost of pipe and other materials, and the freight thereon, is estimated and included in the total expenditure figure. Costs of work done by company forces, such as surveying and buying right of way, also must be included.

When all expenditures have been calculated, a final figure can be established to reflect total estimated investment in the new facilities. This cost, with estimated annual operating expense figured, then can be compared with estimated annual revenue to reflect the company's estimated return on its proposed investment.

Based on findings from such economic studies, management makes the final decision to build a certain size pipe line at a specific estimated cost and authorizes that money be budgeted. Up to this point the project has been chiefly a study. Now it becomes a pipe line in the making.

Field survey parties begin the job of staking out an exact path for the line. Company right of way men move into the area to begin buying and assembling right of way.

Final Planning and Design

Authorization to go ahead sends a project into advanced stages of planning, design, and preparation to build. Up to this time little of the actual detailed physical design work has been done. Engineers, working closely with members of the operating departments, begin fitting a myriad of pieces and details together. Work begins on the expenditure requisition to cover the cost of the project.

Starting with a known pipe size and specified operating pressure, pipe line engineers work out final design for the facilities. All principles of modern pipe line engineering, a science in itself, are applied to assure the ultimate in operating efficiency once the new facilities are in service.

Field investigations are often necessary to examine soil conditions and take cores at various sites for foundation data . . . and to study lake, sea, and river bottoms to prepare profiles and make recommendations for such things as cover and bend design. Soil tests are made by corrosion engineers to determine corrosive inclinations so the most efficient cathodic protection can be included in the initial design. Field studies are made where weighting of the pipe is necessary to determine extent and amount of weight required.

Many specifications and suggestions are furnished by the operating departments involved. Measurement, for instance, specifies station sizes and working pressures for all measuring and regulating stations. Number and position of main line valves are determined to coincide with needs and recommendations of the operating department. Dispatching and communications departments check all remote control facilities, etc.

Final detailed design must be worked out on: Piping arrangements, pipe specifications, meter stations, scraper traps, river crossings, small stream crossings, separators, scrubbers, tanks, anchoring programs, weighting programs, pressure relief devices, valve arrangements, welding specifications, coating specifications, painting specifications, etc.

Design lay-outs and plot plans of all facilities involved are prepared and thoroughly checked by the general office and district engineering and operations departments. Upon approval of all concerned, lay-outs are finalized by the pipe line design section and submitted to the drafting room for complete construction drawings. All items of material not already ordered are fully described, listed and submitted to the material section of the engineering department for requisitioning.

Throughout the planning stages, during surveying and acquisition of right of way, construction engineers help coordinate design with the most feasible methods of construction. Stream crossing sites must be selected, varying right of way widths determined in the light of construction needs. Shove points for marsh construction, for example, are picked well in advance of the time a line is laid.

Detailed construction specifications and final design of all facilities are assembled and invitations to bidders prepared.

When the contract covering construction is drawn up, approved and signed, it means that within a short while men and equipment will begin moving on location to start construction. It's time now for the pipe-stringing trucks, side-booms and welders'

Once acquisition of right-of-way begins, close coordination is maintained between the right of way department and the pipeline construction section of the engineering department. Here, A. W. Riggs, Jr., head of the right of way department, seated, checks route with engineer R. J. Simmons, Jr.

"firing-lines" which symbolize modern pipe line construction. Much of the real story — that which goes on behind the scenes — has been in progress for many months, however.

Planning, teamwork, and experienced personnel are factors that insure success in modern-day pipelining, and it takes generous measures of all three to bring a new pipe line project from its formative stages to time for construction. ★ ★ ★

Field survey party stakes out new UGPL pipeline in South Louisiana.

CLEVELANDS trenching and backfilling on the TRANS-CANADA PIPELINE

● This Cleveland is one of several 320's excavating trench for 34-inch pipe on the 574-mile Alberta-Winnipeg leg of the 2,250 mile Trans-Canada pipeline. Trench for the big line goes as deep as 76 inches, 52 inches wide at bottom. Average production for each Cleveland is better than a mile a day.

Photos courtesy Trans-Canada Pipe Lines, Ltd.

Cleveland 190 backfiller is fast worker, stays right on heels of lowering-in gang in boggy area of western Saskatchewan. One-man-operated, the 190 has all speeds in either direction, maneuvers fast and saves dozer time on crossings. Perfectly balanced on long, sealed-bearing crawlers, it easily negotiates wettest swamps and toughest hills.

Width across trench top varies according to soil conditions. This Cleveland 320, equipped with slopers, is cutting as much as 8 feet wide at the top to 4 feet wide at the bottom. In Saskatchewan's "Little Sahara" region, sloping to these widths was normal.

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To build such a team the associated companies, Natural Gas Pipeline Company of America and Texas Illinois Natural Gas Pipeline Company, initiated a program — one of the first in the field of transmission operations — to instruct the welders in new techniques and to give them a chance to improve on those skills they had already acquired.

A series of winter-time meetings, when pipe line repair schedules are light, brought together the welders in each area. The regular welders and apprentice welders were included in each group.

Also invited to the sessions were district pipe line engineers, superintendents, and a representative from operating headquarters in Chicago.

The "welder proficiency meetings," as they have come to be called because of their emphasis on acquiring greater skill and knowledge, followed a simple format. The major part of the program came from the welders themselves. They used a round table discussion method to air their views and exchange their ideas.

These open discussions were especially worthwhile because they established a pattern of friendly give-and-take and stimulated thought on the part of all participants.

All facets of the meetings reflected the principal theme: "What are the safest ways to make the highest quality welds?"

Cutting and fitting procedures were the first to be considered. The safe use of oxy-acetylene equipment, the layout and hand cutting of pipe, and machine beveling were included.

In the case of the beveling machine, the cut was made under conditions similar to making a cut on a "live" line. The use of mud to control the fire was demonstrated and the tried and true "granny rags" also were used.

X-Ray Inspection Studied

The companies and the welders both were interested in further study of the X-ray weld inspection procedure and felt that familiarity with the operation of X-ray equipment and the ability to interpret the films would be valuable experience.

Before coming to the meetings, each welder completed a position weld on a large diameter pipe. Then, at the meeting, all welds were X-rayed and the film was studied and interpreted for the welders.

The individual study of his own weld on X-ray film gave each welder

Making the first bead of a pipe line weld with gas in the line at atmospheric pressure. Escaping gas burns outside the pipe as welder deposits the weld metal.

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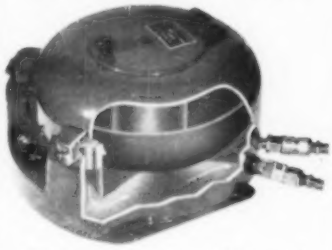

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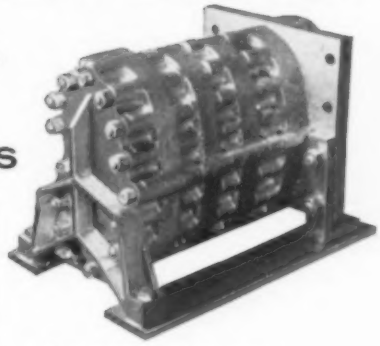

PANHANDLE EASTERN PIPE LINE COMPANY

GARDNER-DENVER Since 1859

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- *for power economy*
  Input horsepower varies with alternating requirements.
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  Hydraulic power completely safe in hazardous locations.
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  Full power output at infinitely variable speeds.
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  Easily applied to toughest power transmission problems. Permits remote automatic control.

With reliability the first consideration in the oil and gas industry, it is not surprising that Berry Drives have gained wide acceptance by operators and equipment manufacturers alike. Berry Drives are synonomous with maximum economy and efficiency in drilling, producing and transmission of oil and gas.

Economical and easy to install . . . adaptable to practically every power transfer need, Berry Hydraulic Pump/Motor Drives assure smooth, sure, foolproof power at infinitely variable speeds. They are instantly reversible. They are quiet running with maximum power efficiency.

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BERRY DIVISION

OLIVER IRON AND STEEL CORPORATION

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This welder is trying to "burn through" apparatus and has just penetrated the pipe.

Typical of the informal discussion meetings was this group talking over the X-ray equipment and learning from the experts and from each other.

an opportunity to observe and discuss his technique with X-ray engineers, who represented the Industrial X-ray Engineers, Seattle, Washington.

These engineers gave talks on the theory of X-ray detection and also discussed the dangers and safety precautions necessary when working with the equipment.

Another safety device was demonstrated and used by the welders to develop familiarity with it. This instrument is the audi-gage, which is used to determine the wall thickness of a pipe in service. The companies insist that it be used at locations where a hot tap is to be made.

"Burn Through" Demonstrated

The most dramatic of the activities at the sessions were the "burn through" demonstrations in which all welders had an opportunity to participate.

This feature, which brought favorable comments from the men who participated, answers the many questions a welder asks himself as he starts on the tense and exacting job of welding on a hot line.

The companies' pipe line division designed a special vessel to simulate actual conditions of welding a pipe.

This apparatus is a section of large diameter pipe with welding heads and necessary connections and vents. A series of 4-in. diam welding caps like coffee cuts are welded to the internal circumference of the pipe, but before they are welded they are filled with gravel and a hole 1/64 in. in diam is drilled in the caps. The vessel is thoroughly purged and pressured before an arc is struck on it.

The demonstration requires the welder to use normal welding heat to penetrate the pipe wall in the molten metal above the place where a cap is welded inside.

The small opening and the gravel in the welding cap allow the pressure to be equalized in the vessel with identical pipe wall stresses throughout the vessel, but, at the same time, it prevents the escape of any appreciable volume of gas when the pipe wall is penetrated.

So, when the welder sets to work, all the conditions are the same as though he were welding a live line.

The demonstration proved valuable from many standpoints. It showed the welders that it is extremely difficult to burn a 0.250-in. wall or heavier pipe with normal welding heats.

The welders also learned that their safety margin was greater than they realized.

Technically, it was learned that the penetration of the pipe wall during welding is only a small opening, and also that the escaping gas cannot be ignited by an electrode.

Everyone at the meetings concluded that welders who have had "burn through" experience are better equipped for welding against pressure.

The use of backup rings when lineups are difficult was demonstrated and discussed.

Safety in working procedures and in dress was emphasized during the meetings. The welders discussed what clothing was appropriate and gave the best protection.

A detailed discussion of fire extinguishers, their use and their care was part of the agenda.

Additional proficiency tests for all district welders were held this summer, including further work with the X-ray of welds and the interpretation of the films.

The benefits of the program are obvious — the welders are more confident and experienced — and can do a better job. The opportunity to draw on one another's ideas and to study one another's techniques have made the meeting a valuable part of the pipe line division's training program.

* * *

NOTICE:
No change except the corporate name. We still have the same ownership, same management, same address, same telephone, and use the same 45 years of experience to render the same service under the same trade name—"PELCO."

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SEE YOUR NEAREST SUPPLY HOUSE
(Formerly: Pelican Well Tool & Supply Company)

WITH THE PIPE LINE CONTRACTORS

● **H. C. Price Company, Box 1111, Bartlesville, Oklahoma.** Has 71 miles of 30-in. line for *Texas Eastern Transmission Corporation* in the Port Lavaca, Texas, area.

● **Fulton Banister, Ltd., 625 Northern Hardware Building, Edmonton, Alberta.** Has 33 miles of 24-in. for *Interprovincial Pipe Line Company* between Peebles and Glenavon, Saskatchewan, to begin construction about June 1.

● **Mannix, Ltd., 322 Seventh Avenue, W., Calgary, Alberta.** Has 100 miles of 3 to 12-in. gathering line in the Pembina field to lay for *Pembina Pipeline, Ltd.* Has 45 miles of 30-in. for *Westcoast Transmission Company, Ltd.*, between Portia and Glenwalker, British Columbia. Has 75 miles of 34-in. to lay for *Trans-Canada Pipe Line Company* between Pense and Candiac, Saskatchewan. Only stringing on this project is now being done.

● **Price-Poole Pipeline Constructors of Canada (joint venture of H. C. Price of Canada Limited and Poole Construction Company, Ltd., Rivers, Manitoba.** Has 99-mile section of 34-in. pipe to lay for *Trans-Canada Pipe Line Company* on a section of line in Manitoba Province extending eastward from the Assiniboine River near Miniota. Right of way has been cleared and limited activity is underway prior to actual construction beginning this spring as weather permits.

● **Missouri Valley Dredging Company, 222 William Street, Omaha, Nebraska.** Has three major crossings on *Sun Pipe Line Company's* 109-mile new products line between Twin Oaks, Pennsylvania, and Newark, New Jersey; the crossings are on the Schuylkill, Delaware and Raritan rivers.

● **O. R. Burden Construction Corporation, P. O. Box 5216, Tulsa, Oklahoma.** Has 8 miles of 20-in. line to lay, also removing and reconditioning same amount of 20-in. products line in Pulaski County, Arkansas, for *Magnolia Pipe Line Company*. Removal operation will begin on completion of the lay job.

● **Dutton-Williams Bros., Ltd., North Canadian Oils Building, Calgary, Alberta.** Has 320 miles of 10 through 4-in. distribution systems for *Inland Natural Gas Company* in Nelson, Savona, and Penticton, central British Columbia.

● **R. H. Fulton & Company, Inc., P. O. Box 1526, Lubbock, Texas.** Has 252 miles of 22-in. line for *Colorado Interstate Gas Company* between Rock Springs and Laramie, Wyoming.

● **Trojan Construction Company, Inc., 1416 N. Robinson, Oklahoma City 3, Oklahoma.** Has contract for takeup and reconditioning 276 miles of 8-in. line for *Sinclair Pipe Line Company* between Jacksboro and Mexia, Texas.

● **Somerville Construction Company, Ada, Michigan.** Has 67 miles of 10 and 12-in. line from Clare County to Traverse City, Michigan, for *Michigan Consolidated Gas Company*. Also has 60 miles of 10 and 12-in. line between Muskegon and Ludington, Michigan, for the same company.

● **Latex Construction Company of Georgia, P. O. Box 184, Fond du Lac, Wisconsin.** Has 90 miles of 16 and 20-in. line between Oshkosh and Milwaukee, Wisconsin for *Michigan-Wisconsin Pipe Line Company*.

● **Lone Star Constructors, 10301 Shady Trail, Dallas, Texas.** Has 94 miles of 18-in. line for *Humble Pipe Line Company* from its Ector Station to the Kemper Station, in West Texas.

● **Dunn Bros., Inc., 801 Mercantile Securities Building, P. O. Box 5771, Dallas, Texas.** Has 105 miles of 34-in. for *El Paso Natural Gas Company* between St. Michaels and Navajo Station, Arizona. Has 145 miles of 34-in. line for *Western Pipe Line Company* east of Flagstaff to Topock, Arizona.

● **H. B. Zachry Company, Box 2570, San Antonio 6, Texas.** Has 330,000 ft of 4½-in. line for *Phillips Petroleum Company* between Coke County and Midland County, Texas. Has three spreads of 30-in. line and river crossings for *Texas Eastern Transmission Corporation*. One spread of 353,700 ft extends from the Rio Grande River to the King Ranch; another, 358,500 ft between Port Lavaca and Highway 35. The river crossings are on the Rio Grande between McAllen and Vidor, Texas.

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WmSON STEEL CLAD INSULATOR

HEAVY DUTY *Insulator for Big-Inch Pipelines in* **OVERSIZE** *Casings*

EXCLUSIVE "SLING JOINT" PREVENTS BAND FROM DIGGING INTO PIPE COATING
ELECTRO-GALVANIZED STEEL BAND, TENSILE STRENGTH 65,000 PSI
FORGED STEEL RUNNERS MACHINE WELDED TO BAND ACTUAL TEST LOAD—92,550 LB. PER RUNNER
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Pipe Line Contractors

● **Hallmac Construction Company, 3701 Buffalo Drive, Houston 19, Texas.** Has 400 miles of 24 to ¾-in. line for *Spokane Fuel and Gas Company* for natural gas distribution system within the city of Spokane, Washington. Job closed down for the winter.

● **Western Construction Company, P. O. Box 798, Austin 64, Texas.** Has 12 miles of 30-in. for *Transcontinental Gas Pipe Line Corporation* between Scottsville and Charlottesville, Virginia. Also has contract for a 30-in. Susquehanna River crossing for the same company.

● **Panama-Williams Corporation, 1418 Melrose Building, Houston, Texas.** Has 76 miles of 4 and 6-in. line for *Phillips Chemical Company* between Pasadena and Sweeny, Texas.

● **Holdren Construction Company, P. O. Box 417, Mount Vernon, Illinois.** Has 12 miles of 3-in. line to lay for *Town Gas Company of Illinois* extending from the Panhandle-Eastern line below Auburn to Girard, Illinois. Also has 42 miles of small distribution lines to lay for the same company in the cities of Virden, Girard, and Thayer, Illinois.

● **M. G. M. Construction Company, P. O. Box. 1056, Concord, California.** Has 25 miles of 6-in. for *Pacific Gas & Electric Company* from San Ardo gas fields to King City, California.

● **Majestic Contractors Limited, 408 Royal Trust Building, Edmonton, Alberta.** Has gathering system to lay for *Westspur Pipeline* in the Midale, Saskatchewan, area. Has undetermined amount of city distribution system for *Consumer Gas Company* in Toronto.

● **Collins Construction Company, Box 86, Port Lavaca, Texas.** Has contract with *U. S. Government Agencies in Europe* to lay 8000 ft of 24-in. sea-loading line in Bay of Biscay. Also has 37,000 ft of 22-in. submarine pipe line installations to lay for the *City of Los Angeles*, California. The installation, the Hyperion sludge line, extends from the beach near El Segundo to a depth of 300 ft offshore.

● **Ross-Powers Construction Company, Box 2038, Billings, Montana.** Has 40 miles of 12-in. line for *Montana-Dakota Utilities Company* between Baker and Glendive, Montana. Also has 10 miles of 6-in. to lay eastward from Cabin Creek, Montana, for the same company.

● **Engineering-Construction Company, 407 First National Building, Tulsa, Oklahoma.** Has undetermined amount of 1¼ through 8-in. city distribution lines in the town of Brookings, South Dakota, for *Northwest Public Service Company*.

● **Houston Contracting Company, 2707 Ferndale Place, Houston 6, Texas.** Has 121 miles of 30-in. natural gas pipe line for *Texas Eastern Transmission Corporation* from a point near Angleton, Texas, east to a point near Vidor, Texas. Work to start about March 1, 1957, based on receipt of pipe and materials.

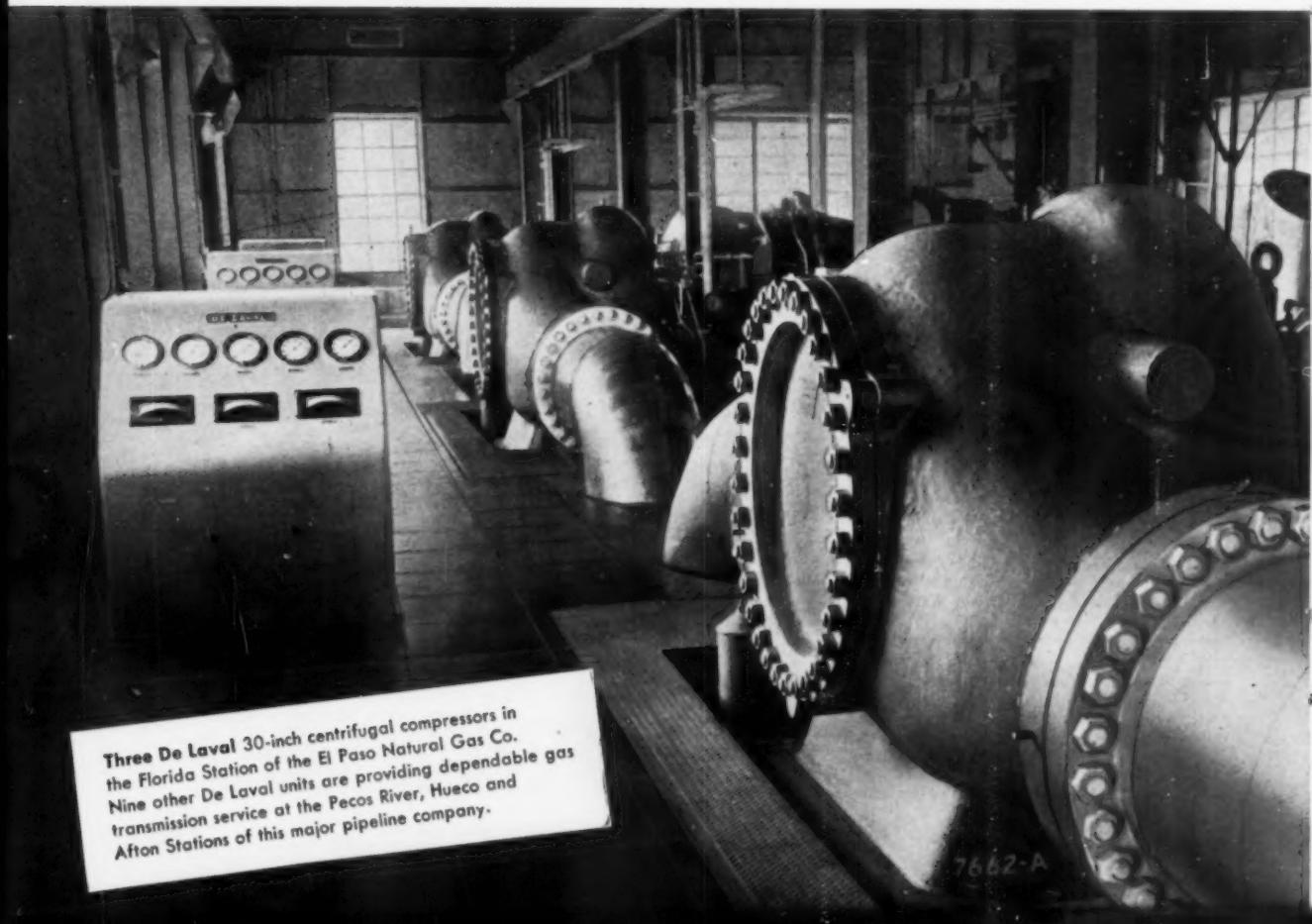
● **Hunsaker Trucking Contractor, Inc., P. O. Box 97, Carrollton, Texas.** Has subcontract for stringing 94 miles of 18-in. line for *Humble Pipe Line Company* between Odessa and Big Lake, via Crane, Texas. Lone Star Constructors, Dallas, is prime contractor.

Trans-Carolina's Application Turned Down by FPC

Proposal of Trans-Carolina Pipeline Corporation of Raleigh, North Carolina, to service tidewater areas has been denied by the FPC in favor of intrastate service.

Trans-Carolina sought approval of a $22,000,000 project to serve with gas the tidewater areas of North and South Carolina. Competitive intrastate projects, by North Carolina Natural Gas Corporation, of Raleigh, and Carolina Pipeline Company, of Greenville, South Carolina, were authorized by their state regulatory boards.

In denying Trans-Carolina's application, Presiding Examiner Emery J. Woodall said that Trans-Carolina "has failed to sustain its burden of proof that the project proposed by it would be economically, engineeringly, and financially feasible." Woodall further found "that the deficiencies in evidence introduced by Trans-Carolina prevents the determination on this record of exactly what the proposed project is, what it is estimated to cost, and hence, what the evidence regarding financibility, cost of service, and rates required to be charged really shows, and what retail distribution of gas by Trans-Carolina to ultimate consumers in what exact distribution areas is proposed."



Three De Laval 30-inch centrifugal compressors in the Florida Station of the El Paso Natural Gas Co. Nine other De Laval units are providing dependable gas transmission service at the Pecos River, Hueco and Afton Stations of this major pipeline company.

Projects

Pipe Line Projects

El Paso's $84,658,000 Project Authorized

The Federal Power Commission has authorized El Paso Natural Gas Company to construct pipeline facilities, estimated to cost $84,658,000.

The project includes a total of about 290 miles of pipeline and 56,950 hp in compressor capacity on El Paso's system in Texas, New Mexico, and Arizona. The facilities will be used to deliver an additional 75,000,00 cu ft of gas per day jointly to Southern California Gas Company and Southern Counties Gas Company of California, both of Los Angeles, and an additional 75,000,000 cu ft to Pacific Gas & Electric Company, of San Francisco. The gas will be delivered through existing delivery points at or near the Arizona-California state line.

Laying of Inland Natural Line to Begin in February

Survey of the natural gas pipeline route to serve Interior British Columbia has been completed by the Inland Natural Gas Company, Kamloops, British Columbia; and actual laying of the main line and distribution system will begin in February.

The 304-mile main line is in addition to 73 miles of lateral feeder lines that also have been surveyed. The first spread will start near Kelowna, and work towards Kamloops, joining with the Westcoast Transmission lines at Savona. The second section will work from Kelowna to Kootenay.

The third section will start at Nelson and work toward the Okanagan. Dutton-Williams Brothers, Ltd., are in charge of building the line.

Great Lakes Announces Extensions to System

Great Lakes Pipe Line Company has announced plans for extension of its system into Wisconsin and improvement of line capacity into its Chicago terminal.

The Wisconsin project will consist of an 84-mile 8-in. line extending laterally to Eau Claire from a point on the company's existing lines south of St. Paul, Minnesota.

A 68-mile 12-in. line will be laid into Chicago from the juncture of Great Lakes' lines with the Badger system. The extension will supplement the original 6-in. line.

515-Mile Line Will Give Four Corners Needed Outlet

Texas-New Mexico Pipe Line Company will construct a 16-in. extension from the company's Jal, New Mexico, pump station to the Four Corners area, where the boundaries of Utah, Arizona, New Mexico, and Colorado meet. The distance is approximately 515 miles.

Initial capacity of the main line will be 50,000 bbl per day, and additional capacity can be obtained, as needed, by the addition of booster stations.

Crude oil production is restricted at present due to lack of pipeline facilities from the area. The pipeline will pass through producing and prospective areas in New Mexico between the Four Corners area and Jal, New Mexico, and at Jal will connect with pipeline facilities serving the Mid-Continent, Gulf Coast, and Southwest areas.

Texas-New Mexico Pipe Line Company is owned by The Texas Company, Sinclair Pipe Line Company, Tidewater Oil Company and Empire Gas and Fuel Company (Cities Service Company).

DE LAVAL

CENTRIFUGAL COMPRESSORS

on the job at El Paso Natural Gas

De Laval centrifugal compressors offer many important engineering features. (1) They are designed to handle an increased ultimate flow, can be quickly converted to larger capacities by replacing the impeller, diaphragm and a few minor parts. (2) The high pressure shaft seal eliminates leakage, consumption of sealing oil is negligible. (3) There is only one moving part—the rotor—which has ample clearance. (4) Units are compact, require smaller foundations and smaller stations. (5) First costs and installation costs are low.

Bulletin 503 gives data on De Laval Centrifugal Compressors. Write for your copy.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY

869 Nottingham Way, Trenton 2, New Jersey

DL375

Transco's Program Authorized

A Federal Power Commission presiding examiner has filed a decision subject to commission review, authorizing the $50,858,000 natural gas project of Transcontinental Gas Pipe Line Corporation.

Presiding Examiner Emery J. Woodall authorized Transcontinental to construct and operate over 350 miles of pipeline to be laid in Louisiana, Mississippi, Alabama, Georgia, South Carolina, North Carolina, Virginia, Maryland, and Pennsylvania. The installation of 12,750 compressor hp and additional facilities at new and existing stations are included in the project.

Gas Line to Florida Approved Conditionally

The joint project of Coastal Transmission Company and Houston (Texas) Gas and Oil Corporation to lay a gas line from South Texas to Florida has been authorized conditionally by the Federal Power Commission.

Coastal's system will extend from southern Texas to the east bank of the Mississippi River where it will connect with Houston Gas' proposed facilities. The Houston Gas system will then extend across the Gulf Coast states and down the Florida peninsula to a point near Miami.

Coastal will build 574 miles of line from a point in Hidalgo County, Texas, to the point of connection with Houston Gas' system in East Baton Rouge Parish, Louisiana. Coastal's facilities also include 414 miles of supply laterals extending from its system to some 42 producing fields in Texas and Louisiana, and 4 main line compressor stations with a total capacity of 16,500 hp. Estimated capitalization of Coastal's project is $54,589,000.

Houston Gas' system will include 942.6 miles of main line extending from the Mississippi River connection across Louisiana, Mississippi, and Alabama, and then eastward across the Florida panhandle and down the Florida peninsula to a terminus south of Miami in Dade County, Florida. The company also will build 682 miles of laterals in Florida to serve 34 distributors and 17 industrial users. The project includes 4 compressor stations, each having a capacity of 6000 hp. The facilities are estimated to cost a total of $94,285,000.

The conditions imposed by the commission require both Houston Gas and Coastal to file gas tariffs within 30 days, eliminating or revising certain features of their previous filings, and to submit their financing plans to the FPC for approval prior to undertaking to put them into effect.

Buckeye to Extend Products System to Chicago Area

Buckeye Pipe Line Company will extend its Midwest products pipeline system westward to the Chicago area during 1957. This will afford shippers from Toledo and other Ohio points a common carrier products pipeline into the Chicago market.

Proposed expansion plans call for the construction and conversion of 116 miles of existing 8-in. crude oil line between Huntington, Indiana, and Griffith, Indiana, to products service. The new terminal serving the Chicago area will be at Griffith where the company has a crude oil tank farm and pump station. Work is to start in April with completion of the project scheduled for July. Estimated cost will be $2,000,000 and Sheehan Pipe Line Construction Company is contractor.

The company also plans an extension of its Toledo to Cleveland products line to the Youngstown, Ohio, area. This project will include the conversion of 32 miles of a former 8-in. crude oil line between the company's Mantua, Ohio, pump station and Ellsworth, Ohio, where the new terminal will be located. Work on this line will begin during the late summer and is scheduled for completion in the month of November.

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to remember
before you let a
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Applying NO-OX-ID "GG" over the cleaned surface

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Finally, NO-OX-ID Filler Red "C," a seal coat, completes protection

THIS PIPE IS 25 YEARS YOUNG

Twenty-five years ago NO-OX-ID combinations sealed this pipe against corrosion. Today, after two and one-half decades of uninterrupted service, the pipe is as good as new.

HOW DO WE KNOW THIS?

Recently, new construction made relocation of the line necessary. Inspection revealed the original NO-OX-ID coatings and wrappers had chemically and mechanically stopped moisture penetration and corrosive attack. *Not a foot of pipe was replaced.* After cleaning and a new application of NO-OX-ID coating-wrapper combination, the pipe was lowered in. It's now ready for many more years of additional service.

Many leading pipeline companies and utilities rely on NO-OX-ID combinations for lasting pipeline protection. Consult your Dearborn representative next time you move pipe or lay new lines for the right combination to meet your soil conditions.

NO-OX-ID ADVANTAGES

Coats more feet per man-hours because less material is needed • Applied hot or cold • By hand, by Traveliner or at the mill • Requires less equipment • No noxious fumes.

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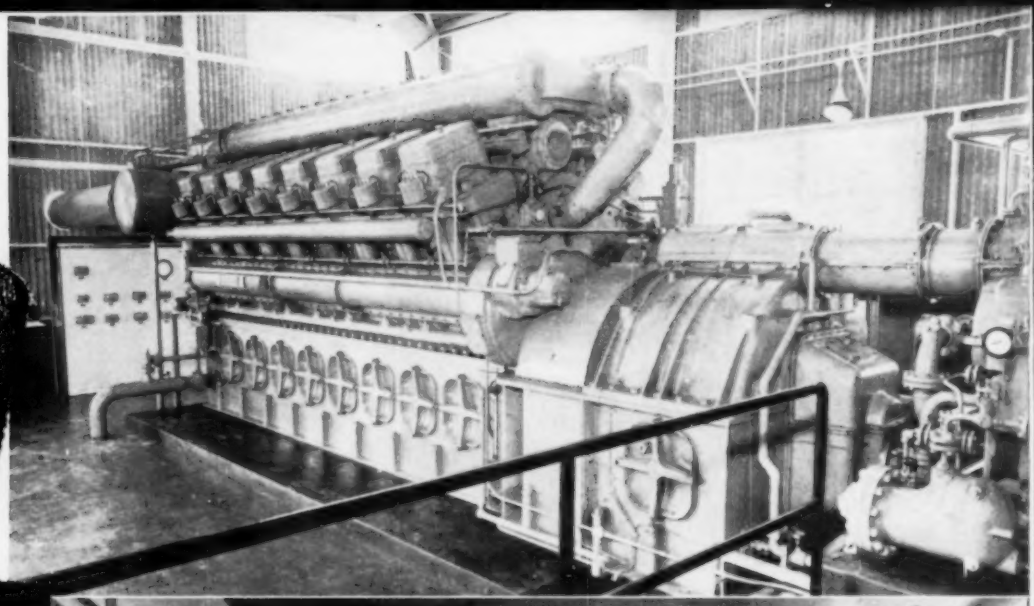

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Backed by this broad experience and proved performance, today's modern line of Nordberg SUPAIRTHERMAL Engines are, by all standards, your best investment in modern prime movers for compact, economical, long term pipe line power. These engines are built in both in-line and V-types, in sizes from 500 up to 5,000 hp, for Diesel, Duafuel® or Spark-Ignition Gas operation.

We welcome your inquiry and the opportunity to assist you in your power study.

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PIPE LINE PERSONALS

▸ Southern Pacific Pipe Lines, Inc., has announced the following appointments. **A. R. Winning** named materials coordinator headquartered in Los Angeles, California and **B. G. Fannin** chief operator-deliveryman headquartered in Tucson, Arizona. Fanning replaces **S. L. Herndon,** who becomes chief operator-deliveryman headquartered in Phoenix, Arizona, succeeding **J. G. Sparks. D. D. Lundgren** has been appointed acting chief clerk, San Francisco, taking the place of **A. D. Balboni** who is on leave of absence.

▸ **Hobart G. Mariner,** general manager of the Service Pipe Line Company, has been elected a member of the board of directors. He will continue as general manager.

H. G. Mariner

E. E. Read

▸ **E. Earl Read** has been appointed to the position of vice president in charge of operations for Mid-Valley Pipeline Company. He was previously general superintendent.

▸ Michigan Wisconsin Pipe Line Company has announced the following personnel changes: **George A. Moore,** superintendent of division 2, named assistant pipeline superintendent with headquarters in the Detroit, Michigan, offices. **James C. Woodruff,** division 4 superintendent, will transfer from Grand Rapids, Michigan, to succeed Moore. **Richard K. Harrison,** assistant pipeline superintendent, becomes superintendent of division 4.

▸ **Creighton R. Hodges, Jr.** has been named chief accountant for Texas Eastern Transmission Corporation. He was associated with the firm of Peat, Marwick, Mitchell & Company in Houston, Texas, St. Louis, Missouri, and Shreveport, Louisiana.

▸ **R. P. Drybread** and **James W. Penn** have joined the gas reserves and availability section of Northern Natural Gas Company at Northern's Omaha, Nebraska, headquarters.

Drybread was with Frankfort Oil Company and Phillips Petroleum Company, both of Bartlesville, Oklahoma, before joining Northern. Penn served in the geological department of Gulf Oil Company before joining Northern.

▸ **Jack N. White** has been appointed superintendent of pipelines for Panhandle Eastern Pipe Line Company, Kansas City, Missouri. He succeeds **D. K. Stephens,** who remains advisor. **John C. Berringer** assumes White's former job as assistant superintendent of pipelines. Berringer was chief corrosion engineer.

▸ **Robert Meiklejohn, Jr.,** of Westfield, New Jersey, has been appointed by Tidewater Oil Company to the post of assistant to eastern divisional transportation manager **R. K. Kelly.**

He was formerly administrative engineer for M. W. Kellogg Company, assistant to the chief engineer of Arthur G. McKee and Company, and as development engineer with Linde Air Products.

▸ **John R. Blewer** has been named manager of community and stockholder relations and **Leon M. Sipes** manager of publications, Texas Eastern Transmission Corporation.

In his new capacity, Blewer will supervise the company's community and stockholder relations program and its advertising activities. Sipes will supervise editing and production of company publications including "The Inch" and the "Texas Eastern News."

▸ The Federal Power Commission has elected Commissioner **Frederick Stueck** to serve as vice chairman during the year 1957. Commissioner Stueck took office as member of the Federal Power Commission July 9, 1954. He succeeds Commissioner **Seaborn L. Digby,** who has been serving as vice chairman of the commission since January 1, 1955. Under provisions of the Federal Power Act, the commission each year selects one of its members to serve as vice chairman. The vice chairman acts in case of absence or disability of the chairman or in case of a vacancy in the office of chairman.

John Potter

▸ **John Potter** has been appointed manager of community relations for Texas Gas Transmission Corporation. Formerly supervisor of publications, he will coordinate the company's activities and press relations in the areas adjacent to its pipeline system. He also will continue as editor of the Texas Gas employee magazine.

▸ **B. E. Harrell** has been named manager of the newly created department of gas supply and gas sales for Arkansas Louisiana Gas Company. In his new position he will be in charge of gas purchases, industrial sales, sales to other pipeline companies, exchange agreements, gasoline plant processing agreements, producer relations, and industrial customer relations.

▸ **Dr. B. D. Thomas** has been appointed the Battelle Memorial Institute's new director. He succeeds **Dr. Clyde Williams,** president, in the management of Battelle's extensive research operations in the United States and Europe.

▸ **William G. Van Gilst** has been promoted general superintendent of compressing stations of the Equitable Gas Company. He had been assistant general superintendent and replaces Judson Bonsall, who died recently. His headquarters are in Clarksburg, West Virginia.

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"My 4T Pow-R-Ditcher is the best machine I've ever used for irrigation lines and gas mains for the Kansas Power & Light Co. It's the finest small ditcher on the market for all-around performance and low cost ditching."

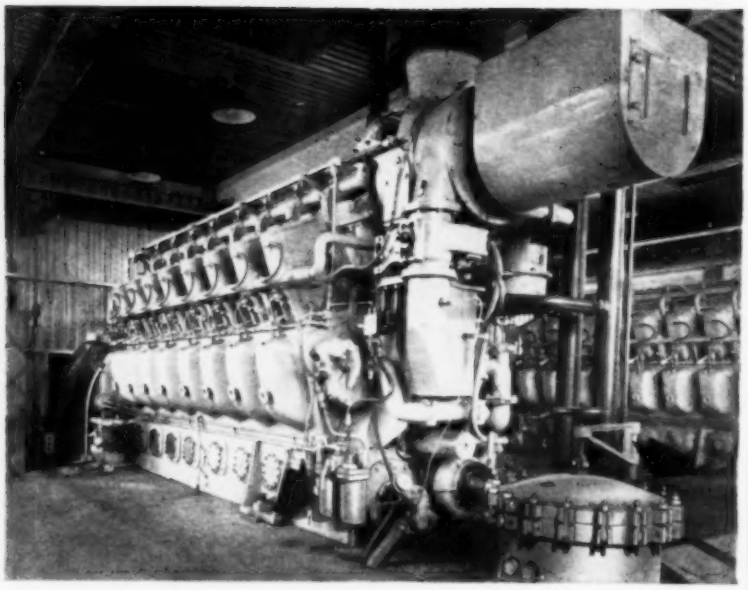
D. Catherman
SALINA CRANE & SHOVEL CO.
Salina, Kansas

VERMEER MIDGET DITCHER DIGS MORE . . . COSTS LESS

Here's just the machine for laying gas pipe, service lines and digging foundation footings. One man operation. Very maneuverable for those "tight spots." Only 48" wide, 6' high, 13' long. Digs 6" to 14" wide and can be transported in a pickup truck. Thousands in use. Write for complete information.

Some Excellent Distributor Territory Available

VERMEER MFG. CO., Pella, Iowa



NUGENT FILTERS

. . . the best protection any engine can have

Nugent Filters protect both lube and fuel oil for the Alco 251 Diesels installed at the Laton (Kansas) Pumping Station of the Service Pipe Line Company. This recently built pipeline conveys crude oil from Fort Laramie, Wyoming, to Freeman, Missouri.

To help guard against the serious consequences of a power failure, a Nugent # 1555-4L12 filter provides the Alco Diesels with full flow filtering of lube oil. The filter cleans all the engine lube oil in circulation every cycle before going to the bearings, removing particles as small as 2 or 3 microns.

Fuel oil, too, receives the protection of Nugent filtering. A #1555-BF-1R Duplex Filter is mounted on the suction side of the fuel oil pump—protection for trouble-free injection.

You can prevent harmful impurities from reaching spots where they can accelerate wear, shorten engine life or cause power stoppage by employing Nugent Filters. They offer a choice of full flow or by-pass filtering with the same unit. Recharges are inexpensive and easy to change. Simple piping makes installation no problem.

Let Nugent show you how to insure long engine life—write for descriptive literature.

NUGENT TRADE MARK

Established 1897

Wm. W. Nugent & Co., Inc.

3424 Cleveland St. Skokie, Illinois

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

Representatives in Boston • Cincinnati • Detroit • Houston • La Junta, Colo. • Los Angeles Minneapolis • New Orleans • New York • Philadelphia • Portland, Ore. • San Francisco Seattle • St. Louis • Tulsa • Representatives in Canada: Montreal • Toronto • Vancouver

John H. Eiseman, of the gas chemistry section of the National Bureau of Standards, has been given the Award of Merit of the operating section of the AGA.

Jack F. Gale, Houston, Texas, has been promoted to the new position of supervisor, gas purchases, by Transcontinental Pipe Line Corporation. Prior to the promotion, he was gas contract representative.

N. W. Lassiter, Jr., Houston, has been promoted to the status of division superintendent in the compressor stations department. He has been senior engineer in the Houston headquarters.

Leonard F. Cowling, superintendent of Transco's Station No. 9 near Linden, Alabama, has been promoted to division superintendent of the compressor stations division headquartered in Atlanta, Georgia.

Lawrence P. Seaton, Jr., formerly repair foreman, has been named to succeed Cowling as superintendent of the Linden compressor station.

Walter H. Buckingham, formerly superintendent of Station 19, Ellicott City, Maryland, has been transferred to the compressor department in Houston as senior engineer.

Frank M. Hamilton, formerly repair foreman, has been promoted to superintendent of Station 19, succeeding Buckingham.

W. A. Ryan has been promoted to general superintendent of Great Lakes Pipe Line Company. In his 21 years' service with the company, Ryan has held numerous assignments in the operating department, the last ten years as area supervisor of terminals, stationed at Des Moines, Iowa.

Ryan helped to construct and later operate one of the first overseas pipe lines built under wartime conditions from Bone, Algeria, to a point near Bizerte, Tunisia.

W. A. Ryan

H. E. Vaughan

Harold E. Vaughan, formerly with Continental Oil Company, has been named assistant to the vice president for gas supply, Transcontinental Gas Pipe Line Corporation, Houston. Vaughan had been superintendent of natural gasoline and gas operations for Continental Oil Company's CATC marine region. Prior to his assignment with the offshore operation, he had been assistant regional superintendent of natural gasoline and gas operations, southern region.

Charles Ashmun, formerly supervisor of oil movements at Lima, Ohio, for The Buckeye Pipe Line Company, has been named assistant to the president at New York City. Other promotions announced are: **John W. Scanlon,** supervisor of oil movements at Lima; **Donld R. Merriman,** assistant to general superintendent at Lima; **Ernest R. Shearer,** assistant superintendent Cygnet division at Lima; **Charles R. Williamson,** assistant superintendent gathering lines at Lima; **George A. Chilcote,** division engineer at Macungie, and **Leland S. Lovell,** chief oil dispatcher at Lima.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEW Pipe Line Equipment

• machinery • supplies • services

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

Dope Kettle Improved. Crutcher-Rolfs-Cummings has improved the design and operation of its Model "SP" Dope Kettles.

Result is a new Model "SPX" Dope Kettle which employs both sweep and propeller agitation of the dope mixture. No choking is required. With double agitation, the filler is never allowed to settle and a steady, constant temperature is maintained.

An International U-123 engine which develops 31.2 hp coupled with a Ramsey transmission and clutch drives the marine-type propeller. Kerosine capacity is 70 gal and engine fuel capacity is 7 gal for approximately 10 hours' service. *Crutcher-Rolfs-Cummings, Inc.*

Circle number (81) on reply card.

Giant Portable Pipe Benders. The Tal Bending Equipment, Inc., announces its Tal One-Shot Giant Portable Benders. They bend 8-in. pipe, and larger sizes, to any degree up to 90 in one single setting. It take 3 min actual bending time, with a 2-hp motor pump, to make a 90-deg bend in the field on 8-in. pipe.

Frame can be folded together onto the top of the hydraulic ram, making it easy to assemble or disassemble and practical for transportation from shop to job. Also available is an attachment for making 180-deg bends in one shot for all pipe sizes. *Tal Bender, Inc.*

Circle number (82) on reply card.

"Electronic Filing" Device. Using short lengths of magnetic tape to provide compact storage and rapid access to almost unlimited volumes of information, the Burroughs Datafile system supplies 10 times the maximum file capacity of any other data processing equipment. Used in conjunction with a Datatron computer, it permits volume-handling of inventories, payrolls, accounts receivable, etc. *Electro Data Division, Burroughs Corporation.*

Circle number (83) on reply card.

Indoor-Outdoor Motor Line. Line of totally protected, vertical solid-shaft P-base motors for all vertical pump installations is announced by Reliance Electric and Engineering. New motors, with normal thrust bearings in all sizes from 1 to 40 hp and high thrust in sizes from 1 to 15 hp, are available in protected, totally enclosed, or explosion-proof enclosures. Designed for indoor and outdoor installations, all are corrosion-proof for long, safe operation under adverse conditions. *Reliance Electric and Engineering Company.*

Circle number (84) on reply card.

Dispensing Pump. A new dispensing pump has been introduced by Multi-Meter.

Designed to fit the standard ¾-in. opening on all size drums from 15 to 65 gal, this pump is entirely steel and chrome-plated to prevent rusting, corrosion or any reaction with soaps, detergents, disinfectants, waxes, liquid fertilizers, boiler chemicals, etc. *Multi-Meter Corporation.*

Circle number (85) on reply card.

New Policy — Faster Service

Commensurate with our policy of better aids for the petroleum industry, we are initiating with this issue a new, faster reader-inquiry system to aid in supplying you with information concerning new products, new literature, and products advertised in this issue.

Our goal with the new system is to get your request in the manufacturers' hands as soon as possible. Our sights are set high — your request to the right man in 10 days.

Along with this, look for more information—in New Equipment —better coverage of the latest tools in construction, the newest in pipelining and outstanding new services that are being made available each month for your improved operation.

—James A. LeVelle
Engineering Editor

Utility Loader-Backhoe. J. I. Case has introduced its new Case Model 320 with "industrial look" and heavy-duty perform-

ance characteristics. Both loader and backhoe are of Case design. Special features include: Hydraulic steering, shuttle transmission, ½-cu yd loader bucket with hydraulic leveling action, and heavy-duty backhoe with exclusive foot-pedal controlled 180° swing. *J. I. Case Company.*

Circle number (87) on reply card.

Cleaner. Nonflammable solvents that will bite into and remove oil, grease, and dirt without harming delicate metal parts or electrical insulation have been made available. Adaptable to vapor degreasing or cleaning by liquid immersion, the solvents will be marketed by the Du Pont Company under its "Freon" trademark.

Big advantage of the "Freon" solvents rests in their safety, both from a personnel exposure and material standpoint. Because they are nonflammable and nonexplosive, they can be used in open shop areas without danger of fire. Three types of solvents are "Freon" MF, with a boiling point of 75 F; "Freon" BF, which boils at 199 F and "Freon" TF, whose boiling point is 118 F. *E. I. du Pont de Nemours & Company.*

Circle number (88) on reply card.

Truck-Mounted Back-Hoe. Production of a Truck-Mounted Davis Back-Hoe in the price range of a tractor-mounted back-hoe is announced by Mid-Western Industries.

Unit will fold and retract on a truck bed for compact transporting. It will fit virtually any one-ton or larger flat-bed truck with no modification of the truck bed. *Mid-Western Industries, Inc.*

Circle number (86) on reply card.

NEW Literature

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

MEN OF FORESIGHT READ NEW EQUIPMENT

MEN OF PROGRESS READ ADVERTISEMENTS

MEN OF ACTION USE READER SERVICE CARDS

How to Make Tractors Do More. How addition of the right tractor job attachment increases production and profit on virtually all types of construction and logging operations is covered in an informative, 8-page catalog. Shown is the complete line of tractor-mounted accessories for Caterpillar-built tractors, including heavy-duty Towing Winches, Worm Drive Winches, Hyspeed Winches, Oil Well Servicing Winch and the Hyster "Donkey" hoist, and Hyster Yarder. *Hyster Company.*

Circle number (89) on reply card.

Industrial Liquid Meters. Revised 16-page edition of Rockwell's ER industrial meter bulletin offers additional information on factors affecting meter selection. It enables single-plant operators to be self-sufficient in ordering. It offers more complete data on meter construction—explaining, with the aid of tables and charts, which case, piston, and chamber are best suited for use with specific liquids. *Rockwell Manufacturing Company.*

Circle number (90) on reply card.

Thermometers and Traction Dynamometers. Brochures on Dillon Thermometers and Dillon traction Dynamometers have been published by W. C. Dillon.

Dillon bi-metallic, stainless steel dial thermometers are widely used in oil refining for checking such equipment as storage tanks, processing vessels, cracking units, etc., as well as for research and laboratory work.

Dillon Traction Dynamometers have an almost unlimited number of uses, among them being for the correct tensioning of guying cables and for all kinds of weighing operations, as well as for numerous tensile testing applications. *W. C. Dillon & Company, Inc.*

Circle number (91) on reply card.

Reciprocating Pumps. A new data sheet which contains complete information on Aldrich 25-hp to 2400-hp direct-flow pumps is available from Aldrich Pump.

It describes and illustrates the Aldrich-Groff "Power-Savr" pump's stepless, straight-line control of capacity — from zero to rated output without any change in speed of power source. In addition to design and material specifications, this condensed catalog also presents dimension tables and a pump selection chart for the complete Aldrich line. *The Aldrich Pump Company.*

Circle number (92) on reply card.

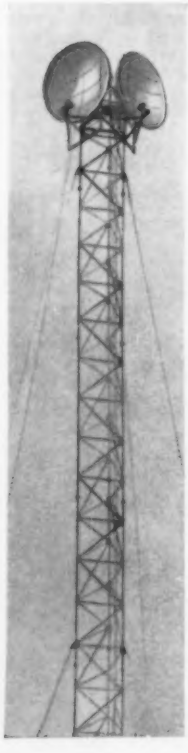
Welders Handbook. A new, 52-page manual is a handy pocket encyclopedia of practical welding know-how needed by operating personnel particularly in the maintenance departments of industry and in welding shops where the variety of metal work is non-routine.

Scope of the manual, published by All-State Welding Alloys, is all methods of metal joinery usual to the welding shop plus cutting without oxygen. It covers work or aluminum and aluminum alloys (including joining aluminum to dissimilar metals), cast iron, copper and copper-bearings alloys, magnesium, monel, nickel, stainless steel, steel, and zinc-base die cast. *All-State Welding Alloys Company, Inc.*

Circle number (93) on reply card.

Side-Loading Handling Unit. Baker-Raulang has issued an 8-page brochure describing its Traveloader. Unit is a side loader and is used in handling pipe, rods, or other long units of material. *The Baker-Raulang Co., a subsidiary of The Otis Elevator Co.*

Circle number (94) on reply card.



S-C

Unusual Opportunity for

TEST ENGINEERS

Carrier and Microwave Experience

Experience in maintenance of carrier and microwave installations desirable.

We offer an unparalleled opportunity for rapid advancement in one of the fastest growing companies in the communications industry. And you'll like living in Rochester—a city of fine homes, superb schools, vast facilities for leisure-time activities.

Immediate openings in Quality Control Dept. Other opportunities for electrical engineers in production engineering.

For immediate interview send letter or resumé to R. E. Golemb, *Quality Control Manager, Telecommunication Division.*

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

Rochester 3, N. Y.

Air Release Valves. V. D. Anderson has published Bulletin 856 on its air release valves which are used to release air from industrial and municipal pipelines and other equipment as water mains, water filters, tanks, brine lines, etc. This literature describes and explains the operations of these heavy-duty air release valves which are made for pressures up to 500 lb. *The V. D. Anderson Company.*

Circle number (95) on reply card.

Silicones. The 1957 Reference Guide to Dow Corning Silicones has been published. Almost 150 commercially available silicone products are described in this catalog, including several which were developed within this last year. As in previous annual issues, products are grouped by usage (water-repellents, dielectrics, release agents, etc.), enabling engineers to locate a material by what it does as well as by what it is. *Dow Corning Corporation.*

Circle Number (96) on reply card.

Valve Selection. A newly revised edition of "Guide for Selecting Valves, Boiler Mountings, Lubricating Devices" has been published by Lunkenheimer. New sections, describing revolutionary new LQ600 Bronze Globe Valves, with Brinalloy Seats and Discs; Luncor PVC All-Molded Valves, and Lunkenheimer Solder End Valves has been added to the 24 pages of tables, technical data, and information. *Lunkenheimer Company.*

Circle number (97) on reply card.

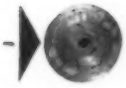
Force Bridge. Catalog C80-1 describes the Sorteberg Force Bridge, a computing device which can be used in pneumatic measurement or control circuits for square root extraction, ratio setting, division, multiplication, squaring, and pressure or temperature compensation. *Minneapolis-Honeywell Regulator Company.*

Circle number (98) on reply card.

Transmitter. A bulletin on the Burgess-Manning low differential pressure transmitter describes the style H electric transmitter with ranges 0 to 2, 4, 6, 8 and 10 in. of water and with working pressure 50 lb per standard inch gage. Illustrations show the construction, dimensions, and operation of the transmitter. Transmitter makes possible the measurement of small differentials without undesirable hysteresis. *Penn Instrument Division, Burgess-Manning Co.*

Circle number (99) on reply card.

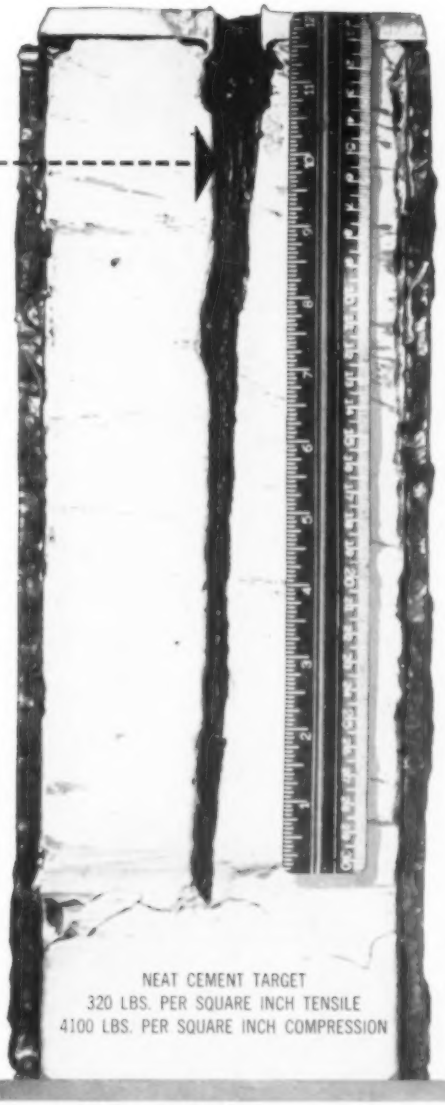
All you see is the "keyhole"



1/8" HOLE IN FLUID SEAL
5/8" HOLE IN STEEL PLATE

1" DIAMETER HOLE IN TARGET

but look at the "hallway" it blasts!



NEAT CEMENT TARGET
320 LBS. PER SQUARE INCH TENSILE
4100 LBS. PER SQUARE INCH COMPRESSION

with

"Karrotfree" Koneshot

Just as the size of a room has no relation to that of the keyhole in its door, you can't judge the depth or diameter of a "KARROTFREE" Koneshot perforation by the tiny hole you see in the screw port when the gun comes out of the hole

The photograph on the right shows what you really get with Lane-Wells exclusive "KARROTFREE" Koneshot Perforating. The screw port shown is the actual one which protected the "POWER-PAK" shaped charge which punched that hole through 3/8" steel plate and nearly 12" into 16-day neat cement. "KARROTFREE" Koneshot was *planned* to do just that – to punch a tiny hole in the screw port, thus trapping formation-plugging carrot and charge debris, and drive deep into the formation for maximum penetration and optimum production. And only the Lane-Wells exclusive "POWER-PAK" shaped charges used in "KARROTFREE" Koneshot can give you this combination of deep penetration and debris-free hole!

Tomorrow's Tools – Today!

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COLD ROLLED

HERE'S GOOD NEWS

for operators who prefer replaceable tool joints!

SEAL GRIP®

A DEVELOPMENT OF

HUGHES TOOL COMPANY

HOUSTON, TEXAS

You can now get the improved HUGHES "Seal-Grip" drill stem assembly that has been especially designed to withstand the increased stresses of deeper drilling. The new assembly is the result of the development and perfection by Hughes of new equipment and techniques for cold-rolling the large land area of drill pipe for "Seal-Grip" tool joints.

The value of cold-rolling has been strikingly demonstrated in a long series of laboratory and field tests. For instance, in laboratory fatigue tests—where pipe is run to destruction—*we have not been able to induce a single failure* in the cold-rolled area of the pipe.

HUGHES "Seal-Grip"—always dependable—now offers the operator the strongest, most versatile and efficient replaceable tool joint assembly he can buy.

Developers of "Flash-Weld," "Seal-Grip" and Counter Bore Weld Tool Joints